

SECTION - 3

ENCLOSURES TO THE SPECIFICATION **Customer's Specification**

SECTION -29

CIVIL WORKS INCLUDING CONTROL ROOM BUILDING

1.0. CONTROL ROOM BUILDING:

1.1 GENERAL:

For all technical aspects not specifically covered by this Specification, PWD, Tamil Nadu/Chennai detailed standard Specifications and Indian Standard specification shall be followed. Wherever there is difference between M.D.S.S. and IS.S, relevant Indian standard specification will supply.

1.2. LOCATION:

The building to be constructed at TANTRANSCO 400 KV sub-station site at Anikadavu village, Tiruppur District, Tamil Nadu State.

1.3. Drawings:

General arrangements drawings (Ground floor & First floorplan indicating the measurements – Not to scale) for control room building are enclosed for reference. Foundation has to be designed by the tenderer based on the Safe bearing capacity of soil at site. The soil exploration (Plate load test etc., as per relevant IS standards have to be carried out by the tenderer. The detailed drawings (plan, sectional elevation, staircase drawings, columns & beams, foundation reinforcement details and all other required drawings of the Control room building are to prepared by the bidder based on the Safe bearing capacity of soil at site and as per the ground & first floor plan enclosed. The detailed drawings are to be submitted and approval obtained before execution of works.

1.4. GENERAL DESCRIPTION OF THE BUILDING:

The building will be designed as RCC framed structure with RCC columns, beams and Chamber burnt class II brick panel walls.

1.5. FOUNDATION:

Immediately after taking over of site the initial leveling for the substation yard shall be carried out with earth moving machinery and consolidated with Power roller as per ISS including watering at Optimum moisture content. The finished yard level shall be given by the department Engineer at site.

The foundation shall be designed by the contractor with RCC columns with suitable footing foundation. An isolated foundation shall be adopted depending upon the load transmitted by the column to the foundation and soil conditions.

The rate for earth work excavation for foundation is for excavation in all soils including shoring, strutting and bailing water if necessary and depositing surplus earth. Vibrator shall be used for laying concrete works wherever necessary. It will be practically difficult to make the bed free of subsoil water if water table is higher. Hence use of dry mix to the minimum extent practicable shall be allowed wherever required based on site conditions.

1.6. SOIL INVESTIGATION:

The successful bidder shall undertake soil investigation as detailed, minimum 2 locations in control room area and 2 locations in yard area to be approved by the purchaser. The cost for soil investigation has to be borne by the tenderer for which necessary provision to be made in their quoted rates by the bidder. Exact safe bearing capacity of soil is to be taken after detailed soil investigation by Tenderer. The trial pit details taken are furnished below for the bidder's reference & to have first hand information about the site.

S. No	Trial pit No	Depth (m)	Nature of soil met with					N - Value
			Clay soil	Medium tense clayey gravel	White kankar	Soft disintegrated rock (white)	Very Soft to soft disintegrated rock (green)	
1	1	1.8	0 – 0.5 m	0.5 -1.0 m		1.0 – 1.8 m		Rebound
2	2	2.9	0 – 0.9 m	0.9 -1.6 m			1.6 – 2.9 m	Rebound
3	3	2.8	0 – 1.3 m		1.3 -2.2m		2.2 – 2.8 m	More than 50
4	4	2.7	0 – 1.2 m	1.2 – 1.7 m			1.7 – 2.7 m	Rebound

1.7. ANTI TERMITE PROTECTION:

The Anti-termite protection shall be carried out if required by the Engineer in accordance with the stipulation made in IS 6313 Part – II 1971 and the quantity and rate quoted shall be based on the plinth area, furnished by the contactor.

1.8. BEAMS BELOW GROUND LEVEL:

RCC M 20 Mix grade beams of suitable sizes (using 12 mm to 20 mm hard broken granite stone) shall be provided for interconnecting columns to support the masonry wall of basement and superstructure. The leveling course will be of concrete M 10 (P.C.C 1:3:6) using 12 to 20 mm metal.

2.0

BASEMENT:

The minimum height of basement will be 500 mm above the finished ground level and the actual height to be maintained shall be indicated by the departmental Engineer at Site. The same will be of brickwork using chamber burnt Class II bricks CM as per specification . The interior will be filled with excavated earth to a level 150 mm below the bottom of the flooring concrete and top 150 mm filled with river sand. Flooring concrete and top 150 mm filled with river sand. Flooring concrete will be laid on sand bed.

2.1 SUPER STRUCTUTE:

The inside face of walls shall be plastered with CM 1:5, 12 mm thick and ultimately finished with two coats of interior emulsion best quality over prime coat. The outside face of the walls shall be plastered with CM 1:5, 12 mm thick and finished with two coats of exterior emulsion paint over a primary coat. In toilets, Glazed tiles dadoing up to a height of 2100 mm all-round from floor level shall be provided.

2.2 FIXING ACID RESISTING TILES IN BATTERY ROOM:

Flooring for acid resistance tiles shall consist of 100 mm thick M10 grade concrete using 40 mm hard broken stone and top plastered with 12 mm thick in CM 1:3. then apply one priming coat of acid resistant special paint on the plastered surface and over that provide impermeable membrane of thickness 5 mm to 6 mm. Using bitumastic compound. Over this, the acid resisting tiles are fixed using SK mortar (prepared by using silicate powder with K. solution and cement prodder (Grade S powder and cement prodder (Grade K) solution on the surface and joins painted with same mortar.

2.3. GLAZED PARTITION:

Should be provided as per drawing with Alu.frames as per specification and as decided by the Engineer at site.

3.0. ROOFING AND FLOORING:

The first Floor and the roof slab shall be of RCC M20 mix and of suitable thickness and reinforcement. These slabs shall be supported on RCC M20 mix beams of suitable size and reinforcement. The top of the roof slab shall be provided with weathering course consisting of one course of pressed tiles of size 150 x 150 x 20 mm or 200 x 200 x 20 mm embedded in CM 1:3 mixed with crude oil 10% by weight of cement and pointing with cement mortar 1:3 mixed with crude oil over a bed of brick jelly concrete in lime (proportion being 32:12.5, 80 mm thick). (including water proofing treatment over roof to prevent leakage) The underside of the roofs and the floors and all round the beams shall be plastered with CM 1:3, 12 mm thick. Necessary slope for roof slabs will be provided in the brick jelly concrete (weathering course).

Flooring for ground floor shall consist of 100 mm thick M10 grade using 40 mm size hard broken granite stone and top plastered with granolithic finishing or mosaic finishing or ironite finishing or acid resistant tile work / PVC tile work depending on requirement as approved by the purchaser.

4.0. DOORS, WINDOWS AND VENTILATORS:

The doors, windows and ventilators shall be of aluminium/steel and as per control room building drawing. The door frame shall be of steel section or aluminium section with all necessary iron holdfast, brass oxidized fittings and fixtures etc. as approved by department Engineer at site

Steel windows and aluminium windows shall be provided with fully glazed shutters. Iron grills shall be provided to the steel windows and steel ventilators as directed by the field Engineer.

The contractor shall submit drawings for doors, windows and ventilators within three months of award of contract and approval obtained from Board before manufacture.

5.0. PAINTING:

Doors, Windows and Ventilators shall be painted with two coats of approved first class enamel paint over a primer coat. All wood embedded in or in contact with masonry or concrete shall be painted with two coats of solignum before fixing.

6.0. RCC LINTELS AND SUNSHADES:

RCC lintels and sunshades of suitable depth/thickness with M20 grade with required reinforcement shall be provided.

7.0. STAIR CASE:

Two stair cases with Chromium coated hand rail of 75mm pipe to height of 1000 mm and support and side stiffener with 25mm square / round shall be provided as directed by dept Engineer at site.

8.0. DRAINS:

Suitable downfall PVC pipes 100 mm dia shall be provided as directed by Engineer in the field.

9.0. SANITARY FITTINGS:

Lavatories will be provided in the places shown in the control room drawing, this shall be of flush out type of white porcelain. They should be fitted with traps anti-syphonage arrangements, nahni traps, stoneware connection to sewer line , PVC cowl etc.,

Indian Water Closet, Orissa type white in color, pan of size 630 x 450 mm with "S" or "P" trap with flushing system of approved quality shall be provided E.W.C. and uninals may also be provided with suitable flushing system in some of the toilets as decided by the field Engineers. Wash Basin or Superior quality with all accessories with mirror shall be provided at places as directed by the field Engineer. The sewer connections shall be taken to the outside main sewer for connection to septic tank.

10.0. WATER SUPPLY:

Water Supply lines shall be provided within the building with all necessary fittings as per requirement and as directed by field Engineer. Water supply for the building shall be from the overhead tank of suitable capacity as per specification to be constructed as part of the building.

11.0. FALSE CEILING:

The false ceiling shall be with Gypsum board 12.5 mm thick using suitable required size of Anodized Aluminium section / other materials perforated gypsum board .False ceiling material shall be supported with Aluminium "T" sections of size 25 mm x 1.6 mm. the "T" section shall be placed at 0.5 x 0.5 m spacing. The false ceiling together with Aluminium "T" frame work shall be supported from the ceiling of the building with ¼ inch GI rod hangers at suitable spacing.

12.0 UNDER DECK INSULATION:

The portion of the roof slab above false ceiling in control room area and PLCC room shall be insulated with 50 mm thick thermocole. This under deck insulation is to be carried out for purpose of air-conditioning work. The design for arriving at the size of the air-conditioning units shall be based on the assumption that the inside portion of the roof slab in these areas are provided with under deck insulation.

13.0. CONTROL ROOM BUILDING LIGHTING, CEILING FANS, EXHAUST FANS AND EMERGENCY LIGHTING:

The split up details of various requirements have been furnished in the following sections. The entire electrification shall be carried out as per standard PWD practice.

13.1. SPLIT UP QUALITY OF LIGHTS – AREA WISE:

The type of fitting are as per the schedule and sample to be approved by department engineer at site before actual execution. A electrical circuit diagram shall be prepared by the contractor and got approved before commencement of work.

13.2. SWITCH BOARDS:

13.2.1. MAIN SWITCH BOARD:

The main switch board shall be of indoor, industrial wall mounted, vermin proof, dust proof and suitable for 400/440 V, 3 phase, 4 wire system with bus bar chamber, interconnections and cable glands with the following ratings of incoming and outgoing circuits bus bars shall be rated for 200 Amps complete with angle iron frame work shall be provided.

INCOMER : 1 No. 200 Amps TPN Fuse switch (with HRC fuse).

OUTGOING : 3 Nos. 63 Amps TPN switch fuse.
: 1 No. 32 Amps DP switch fuse and
: 2 Nos. 63 Amps DP switch fuse and with HRC fuses.

QUANTITY : 1 No.

A change over switch for alternate supply shall be installed by the contractor

13.2.2. SUB DISTRIBUTION BOARD:

The sub-distribution board shall be of indoor, wall mounted, vermin proof, dust proof and suitable for 400/440V, 3 phase, 4 wire operation complete with bus bar chamber, bus bars, interconnections m cable glans etc., with the following incoming and outgoing.

INCOMER : 1 No. 63 A TPN isolator.

OUTGOING : 3 Nos. 32 A Double pole HRC fuse HRC fuse
switch

QUANTITY : 2 Nos.

13.2.3. LIGHTING DISTRIBUTION BOARDS:

The lighting distribution boards shall be of Indoor, vermin proof, dust proof and flush mounting type and suitable for operation on 230 V 1 phase, 50 Hz., complete with bus bar chamber, inter connections and suitable knock-outs

for 25 mm dia pipe and glands for incoming cable, shrouds with the following incoming and outgoing minimum circuit breakers.

INCOMER : 1 No. 60 A Double pole.
OUTGOING : 10. Nos. 5A SP, MCBH and 2 Nos. blanking plate
QUANTITY : 6 Nos.

13.2.4. POWER DISTRIBUTION BOARD:

the power distribution board shall be of indoor, wall mounted, vermin proof, dust proof shall be of 230 V 1 phase 50 Hz., with bus bars, interconnections etc., with following incomer and outgoings.

INCOMER : 1 No. 63 A Double pole.
OUTGOING : 12 Nos. 15 A HRC fuse
QUANTITY : 2 Nos.

13.2.6. Convenience sockets like 20 A, 5A sockets shall be provided for essential requirements.

For earthing the distribution Board/Switch Board, No.8 SWG Copper from existing main earth bus shall be used.

Lighting circuits, Fan, 5 A sockets, bell push and exhaust fans shall be wired with 2 runs of 1.5 sq.mm copper wire in $\frac{3}{4}$ " PVC pipes with 14 DWG T.C. (for earthing). 20 A sockets shall be wired with 2 runs of 6 sq.mm copper wire in $\frac{3}{4}$ " PVC pipe with 14 SWG T.C. (Earthing). Concealed type wiring shall be done.

All the fitting sockets, switch Boards shall be provided only at those places marked in the electrification drawing to be supplied by tenderer.

13.2.7. SOCKETS AND SWITCHES:

Totally enclosed, dust and vermin proof, metal clad with cast aluminium enclosure 20 A, 1 phase, 3 pin fully interlocked switch socket suitable for flush mounting. 15 Nos.

5 Amps single pole, single way, porcelain base base flush type switch, suitable for flush mounting 149 Nos.

5 Nos. 1 phase 3 pin switched socket suitable for 220 V AC operation with M.S. Box suitable for flush mounting 46 Nos.

Bell with bell-push switch 3 nos.

Staircase switch, 5 Amps, double pole, double throw, porcelain base flush type switch for staircase light control 4 Nos.

14.0. PERIOD OF COMPLETION:

Time is the essence of this contract. The construction of control room shall be completed and made ready for erection of panels and other equipment's so that the substation can be commissioned within the stipulated period of Fifteen (15) months from the date of award of the contract.

15.0. WORK SCHEDULE:

The work under this contract shall be performed in such a manner so as to complete all the activities and commission the entire 400 KV sub-station within Fifteen (15) months as per the work schedule submitted by the contractor.

The contractor shall furnish preliminary and tentative Bar Chart and work schedule. The contractor shall submit a detailed Pert/bar Chart within 15 days of signing of contract, covering all the major activities such as approval of designs/drawings, supply of all bought out/manufactured items etc., The charts should be self explanatory and the required dates for any significant point of communication or transfer of responsibility between the contractor and other participants in the project shall be clearly brought out.

The above pert network/bar chart shall be discussed and finalized within 30 days of contract finalization and shall form the basis of execution planning.

The contractor shall submit month-wise cash flow statement for the contract based on the schedule of supply of various equipments/materials and erection activities within 40 days of signing of contract. The contractor shall also submit a manpower schedule indicating the deployment of manpower (skilled and unskilled) for all the field activities within 40 days of signing of contract.

16.0. PROGRESS REPORTS:

The contractor shall furnish to the purchaser monthly progress reports in triplicate on the last day of every month indicating the following.

- (i) Item of work.
- (ii) Schedule of progress for the month
- (iii) Actual progress
- (iv) Reasons for shortfall
- (v) Steps taken to meet the shortfall.

In addition to the above status review progress report, the contractor should also furnish the PERT network updated to the Engineer. Whenever there is any likelihood of a change in his construction schedule, the contractor should inform forthwith and obtain concurrence from the Engineer. The contractor shall submit the weekly programme of work on the last day of previous week .

17.0. TESTS:

All routine and acceptance tests as per relevant I.S.S. for the materials supplied by the contractor shall be carried out in the presence of Board's representative and test reports got approved before dispatch.

18.0. CABLE TRENCH:

18.1. RCC cable trenches of 1200 mm, 900 mm, 600 mm & 450 mm wide (clear inside) and the cable ducts under road crossings shall be constructed on reinforced cement concrete. The cable trenches shall be provided with R.C.C. cover slabs. Tentative drawings for trenches will be provided by the Board for reference. Design & drawings for these shall be submitted by the contractor and shall be got approved before execution.

18.2. ACCESS ROAD:

The width of roads shall be 8.0 m for Tr gantry road, 6.0 m for main access road and 4.0 m for other branch roads.

19.0. TESTING AND COMMISSIONING:

The testing and commissioning is under the contractor's scope of work and to be carried out in presence of Board officials.

20.0. GENERAL:

All technical and general correspondence may be addressed to Chief Engineer/Transmission/ TANTRANSCO, 6th floor/NPKRR Maaligai, 144, Anna Salai, Chennai – 600 002. All correspondence regarding bills and payments may be sent to the Superintending Engineer/GCC/TANTRANSCO/ Coimbatore with intimation to the Superintending Engineer/Transmission IV , TANTRANSCO, 6th floor/NPKRR Maaligai, 144, Anna Salai, Chennai – 600 002.

21.0. ANIKADAVU 400 KV SS.

21.1. Design and drawings to be submitted by contractor.

The contractor shall arrange to submit the designs together with detailed calculations for the following:

The design shall conform to the relevant standard and latest practices.

- (i) Control room building foundation.
- (ii) Air conditioning of control room & PLCC rooms
- (iii) Earthing system
- (iv) Cable ducts.
- (v) Culverts
- (vi) Foundation for the towers and equipment foundations if necessary design of structures.
- (vii) Transformer foundation design, and detail drawings.
- (viii) Circuit Breaker support structure and support structure for isolator.

21.2. THE CONTRACTOR SHALL FURNISH ONLY DRAWING FOR THE FOLLOWING:

- 1. Detailed drawing for electrification of control room building.
- 2. Access Road.
- 3. All type of clamps, fittings hardware's & sag compensating spring.

The designs/drawing shall be got approved by the purchaser before commencing the manufacture/Construction/Erection.

The purchaser has got the unfringed right to use these designs and drawing for any other 400 KV SS that may come up in future.

All the 400 KV equipment such as circuit breakers, CT's, CVT's, isolator, earth switches and LA's shall be erected as indicated in the electrical layout drawing and as per standard erection practices. The manufactures erection recommendations shall be followed.

Drawing supplied by purchaser.

- 1. Drawing: Electrical & Civil layout layout of Anikadavu 400 KV SS.
- 2. Drawing: General plan (Ground & First floor) of Control room building, tentative drawings for cable trenches, general assembly drawings for 400,230 & 110 KV structures with bill of materials. Shop floor drawings to be developed by the bidder and Five copies of the same with soft copy (CD)

to be furnished after approval of the PROTO ASSEMBLY and other available drawings.

22.0. CUTTING, LEVELLING & FILLING:

Immediately after taking over of site the initial leveling for the substation yard shall be carried out with earth moving machinery and consolidated with Power roller as per specification including watering at Optimum moisture content. The finished yard level shall be given by the department Engineer at site.

22.1 MATERIALS:

Earth used for filling shall be selected earth as approved by the Engineer and free from organic and other objectionable matter. As far as possible excavated earth from excavation for foundations within the project areas shall be used for filling. All clods of earth shall be broken or removed Expansive soil shall not be used. The contractor shall indicate in his offer the location of borrow areas and type of soil that he proposes to use.

Soil having plasticity index less than 20 and maximum proctor laboratory dry density more than 1.5 gm/cc shall only be used.

Adequate dewatering facilities like dewatering pumps, pipes etc., shall also be provided by the contractor for this work including for excavation in borrow areas at his own cost.

22.2. INITIAL LEVELS:

The contractor shall carry out the survey of the site before starting any work by taking accurate cross-section of the areas perpendicular to established grid/reference lines at 5 m interval or other intervals chosen by the Engineer based on the ground profile. For embankments initial levels shall be taken along the line of embankment and at right angles to the proposed alignment. These shall be checked by the Engineer and thereafter properly ordered.

22.3. CLEARING:

The area to be graded shall be cleared of plants, logs, stumps, bush vegetation, rubbish slush etc., If any roots of stumps of trees are met they shall also be removed. The area shall be stripped to depths as specified or as directed by the engineer (minimum 300 mm) of loose sand/fragmented rock in all types of stratum. The material so removed shall be disposed of as directed by the Engineer including burning if necessary. Trees to be cut shall be marked and the Engineer's approval taken before felling them. After the tree is cut and roots taken out the pot holes formed shall be filled with good earth in 250 mm layers and compacted. The tree shall be cut in suitable pieces as instructed by the

Engineer, stacked and delivered to the owner. After the area is cleared of plants, logs, vegetation etc., the filling area shall be compacted with power roller of 8.10 tonne capacity to obtain 90% of maximum proctor laboratory dry density of top soil as per IS:2720 part VI. Initial level shall be taken again as described in the above clause. These initial levels shall be considered for calculation of compacted volume of fill subsequently.

22.4. CLASSIFICATION OF EARTHING WORK:

The earthwork in excavation may be classified under the following four broad categories for the purpose of measurement.

22.5. HARD GRAVELLY SOIL & LOOSE/DENSE SOIL & MURRAM:

Hard gravelly soil mixed with small size boulders, stoney earth, red earth, shales, murrum etc. shall refer to all kinds of loose or dense soil mixed with boulders requiring the use of ordinary implements and not requiring the use of jack hammer, crowbar or blasting.

22.6. SOFT ROCK:

Soft or disintegrated rock requiring the use of pick axe or crowbar but not requiring the use of blasting.

22.6.1. MEDIUM ROCK:

Medium rock and dense medium rock requiring the use of pick axe or crowbar but not requiring the use of blasting.

22.7. HARD ROCK:

Rock which cannot be otherwise removed by using pick axe or crowbar and blasting has to be resorted to.

It should be noted that whatever the means, the contractor may otherwise adopt to remove the earth, the decision of the engineer as regard to the classification of the materials shall be final and binding.

22.8. GRADING:

The grading shall be carried out so as to obtain the levels indicated in the drawing after compaction. Generally such grading includes cutting and filling. The contractor may employ any suitable means, compact thickness and compacted using Power rollers so as to obtain a density desired by the Engineer normally minimum 95% of proctor dry density for cohesive soils and 85% of relative density for non-cohesive soils.

When a layer of loose earth over an area has been removed during grading, the area shall be prepared by ploughing to loosen the earth before addition of soil to make up the lost earth. After the addition of soil over the ploughed area, it shall be compacted to the desired density. The slope for general site grading shall be 1 in 500 or 1 in 1000.

22.9. EMBANKMENTS:

The finished formation width, side slopes and grade of the embankment shall be true to the line and level as shown on the drawings.

The embankment shall be made up in layers not exceeding 250 mm thickness (un-compacted thickness). Over the whole width between the surface of the side slopes and shall be slightly concave in section so as to retain the water for water subsidence. All large clods shall be broken up.

When the embankments are on side-long ground the whole area of the embankment on slope shall be benched out of stepped so as to prevent the material from slipping.

In construction of embankment over the culverts or pipe drains care shall be taken to bring the embankment up, equally on both sides and over the top of the structure. Earth embankment shall be compacted as carefully packed to the depths as shown on the drawing. If embankments are made from borrow pits, the contractor shall excavate the earth from borrow pits by own arrangement of contractor. They shall be regular in width and shape and shall be properly graded, drained and finished with neatly trimmed slopes.

22.10. SHORING AND STRUTTING:

The contractor shall provide all necessary shoring and strutting required for the proper execution of earth work after getting approval from Engineer. The contractor shall also provide design of shoring and strutting for prior approval of Engineer. The details of any special arrangements like sheeting, cofferdams diaphragm walls, etc., shall be submitted to the engineering. The cost of providing shoring and strutting shall be included in the unit prices quoted by the contractor for excavation.

22.11. PROTECTION:

The contractor shall provide and remain required decking, guard fencing, roping, planking, sign boards, red lights, etc., required to maintain safe pedestrian and vehicular traffic and for safety of persons and property.

22.12. PRECIOUS OBJECTS, RELICS, OBJECTS OF ANTIQUITY ETC.,:

All gold , silver, oil, minerals, archaeological and other findings of importance, trees cut or other materials of any description and all precious stones, coin, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of purchaser and ;contractor shall duly preserve and deliver the same to such person as purchaser may from time to time authorize or appoint to receive the same.

22.13. TESTING AND ACCEPTANCE CRITERIA:

The degree of compaction shall be as specified above or as decided by the Engineer as per site conditions. The actual method of measuring the compaction will be decided by the Engineer. The contractor shall carry out at his own cost the required tests to prove that the soil has been compacted to the desired dry density. These tests shall be carried out at different stages of filling and also after entire fill height has been completed. Since the degree of compactions largely depends on moisture content of soil, a close watch shall be kept on it and corrections done to optimize the moisture content. Generally the moisture content shall be brought to within plus or minus 2% of optimum moisture content prior to rolling. The quality control operations shall include but not limited to the following items of work.

- (i) Lines, levels and grades
 - a) Periodic surveys.
 - b) Establishment of markers, boards etc.,
- (ii) Grading.
 - a) Checking the quality of fill material.
 - b) Checking moisture content of fill material.
 - c) Checking degree of compaction.

If a layer fails to meet the required density, it shall be reworked of the material shall be replaced and method of compaction/requirement altered as directed by the engineer to obtain the desired density.

23.0. SPECIFIC TECHNICAL REQUIREMENTS:

23.1. GENERAL:

(a) Before, taking up the detailed engineering of various works, the successful bidder shall be required to prepare the detailed design criteria for various civil works covered in the scope of this contract and shall submit the same

to the purchaser for approval. No design shall be taken up without the written approval to design criteria by the purchaser.

23.2. Foundations for Gantry Structures & Equipment Supporting Structures.

23.1. Foundations shall be designed for the worst combinations of dead loads, live loads, inertia forces, wind and seismic loads, short circuit forces and secondary effects such as shrinkage, rise and fall in temperature, service conditions arrived based on equipments or arrived at based on detailed structural analysis of the switchyard gantry structures, equipment super structures etc., for the design of foundations, the following specific technical requirements shall be met with without any deviation.

(1) All tower/gantry structures and lightning mast foundations shall have stub angle embedded in the foundation while equipment supporting structures shall have foundation bolts and base plate type of connection for transferring the load from super structure to the foundations.

(2) Normally, all the four legs of tower/gantry structures column/equipment supporting structures shall be supported on a common foundation until and unless the leg spacing of structures at foundation level and soil conditions permit isolated foundation under each leg of the structure. For checking the stability of the tower/gantry structure columns/equipment supporting structures foundations, the following factor or safety shall be used.

- (a) Normal and broken wire condition. : 2.2
- (b) Broken wire condition with short circuit forces : 1.65

The stability of foundation shall be checked against overturning, bearing on soil, uplifting, uprooting sliding etc.,

(3) The presence of surface/sub-soil water shall be duly considered in the design of all foundations and under ground faculties.

(4) The structural design or the foundation shall be done as per limit state method of design as given in IS:456 – 2000 and considering the following partial safety factors on working loads.

- (a) Normal and broken wire condition: : 1.5
- (b) Broken wire condition with short circuit forces. : 1.2.

23.2.2. All foundations shall also be designed so as to satisfy and meet the following requirements.

(a) The chimney/pedestal of the foundations shall, atleast, be 300 mm square providing a minimum clear concrete cover of not less than 100 mm

over any part of the stub angle in case of dry locations and atleast 450 mm square with minimum clear concrete cover of not less than 1.50 mm over any part of the stub angle in case of wet locations.

(b) The Chimney/pedestal top shall extend 250 mm (Minimum) above finished ground level and coping shall be upto 50 mm below the joint between the bottom bracing and the leg members.

(c) In all foundations, a lean concrete M10 grade sub-base having a thickness of 75 mm and of size equal the 75 mm more all around of footing size shall be provided under structural concrete. The lean concrete shall be of grade M-10 (1:3:6) conforming to IS: 456 – 2000. The lean concrete sub-base provided under the footings shall not be considered in the structural calculations.

(d) The embedded end of the stub angle shall have a 150 mm thick clear concrete cover upto the top of the lean concrete sub-base in the case of dry foundations and a 200 mm thick clear concrete cover in the case of wet, partially submerged and fully sub-merged foundations.

(e) The depth of foundation below ground level shall not be more than 3.0 m. However no foundation shall rest on black cotton soil and minimum depth inside the weathered rock shall be at least 300 mm.

(f) The joints between the tower subs and the super structure bracing members shall be 300 mm above ground level.

(g) The centroidal axis of the stub shall coincide with the axis of the Chimney. The design of the foundation shall take into account the additional forces resulting from eccentricity introduced due to any reason.

(h) the chimney shall be designed as a composite member for combined action of axial forces viz., compression & tension and bending moments due to both the horizontal shears in both the directions, namely longitudinal and transverse. The adequacy of chimney section shall be checked as per above and necessary reinforcement in chimney shall be provided as per above and necessary reinforcement in chimney shall be design requirements. The design shall be carried out in accordance with IS:456 – 2000 as limit state method of design. However, minimum four numbers of 12 mm diameter bar or 0.15% of cross sectional area of chimney whichever is more than shall be provided and spacing of main reinforcement bars shall not be more than 300 mm. The arrangement of reinforcement shall comply with all the requirements specified in IS:450 – 2000.

(i) Wherever reinforcement is provided in foundations, the clear concrete cover to reinforcement shall not be less than 50 mm.

(j) The bottom slab/pod shall be designed both for bearing pressure as well as dead load of foundation and over weight of earth. The partial safety

factors for the structural design of footing slab shall be same as specified for chimney.

(k) The structural design of foundations shall be strictly in accordance with IS:456 – 2000 and other relevant I.S. codes. The design of R.C.C. foundations shall be carried out by limit state method in accordance with IS:456 – 2000.

(l) The minimum thickness of footing slab for foundation shall not be less than 250 mm in case of dry locations and 300 mm in case of wet locations.

(m) The minimum thickness of footing slab of the edges shall not be less than 150 mm as specified in IS:456 – 2000.

(n) In the design of footing slabs, actual soil pressure under the footing shall be considered to calculate the maximum moments and shears at various sections. The critical sections for moments and shears shall be as specified in IS:456 – 2000. The reinforcement in the footings shall be accordingly calculated and provided.

(o) The footing slabs of all foundations shall be cast without any construction joints. However construction joint shall be allowed between footing slab and pedestals/chimney.

23.3.0. CABLE & PIPE TRENCHES:

(a) Cable and pipe trenches shall be of reinforced concrete type with removable type reinforced cement covers. These trenches shall not be used as storm water drains. The bed of the cable pipe trenches along their length shall be provided a slope of 1:750 to 1:1000 by laying P.C.C. (1:2:4) in second stage to drain any rain/seepage water which may enter them. The overall depth of various type of cable/pipe trenches shall be so decided to take care of above provision of longitudinal slope along their length by laying P.C.C. in second stage without compromising the clearance required between bottom most tray of cable trench and bed of the cable trench.

(b) Suitable expansions joints shall be provided in cable/pipe trenches as per I.S. Specification with PVC water stop bitumen impregnated filler boards, bitumen sealing compound as per specifications or as directed by the purchaser. The water proofing cement additive shall be used for the construction of cable trenches to ensure water tight construction.

(c) The water from cable trenches shall be collected in suitably located sumps from where this water shall be disposed off by pumping into nearest storm water drains. The sump pits shall be of R.C.C. construction covered at top with provision of main hole, rungs and installing 2 Nos. of 100% capacity suitable pumps for pumping out the water from the sump pit with auto

start and auto shutdown depending upon the level of water in the sump pit. The scope shall also cover all accessories like suction and discharge pipes for transferring water from sump pits to nearest storm water drains. The grade of concrete for the construction of sump pits shall be of grade M-20 conforming to IS:456 – 2000 and this Specification.

(d) The suitable lugs of reinforcement steel (10 mm dia. Minimum) shall be welded to edge protection angles for ensuring their fixity in the concrete. The weight of a single cast R.C.C. cover shall not be more than 75 kg. suitable fitting hooks shall be provided for easy handling of these covers.

(e) The covers of cable trenches shall be of such design s not to allow any rain water to enter into them. Necessary embedded steel plates of size 10 x 10 mm thick shall be provided for supporting the cable trays.

(f) The top of cable trenches shall be kept 150 mm above finished ground level. The backfilling shall be done with coarse sand.

(g) In cable/pipe trenches, construction joints shall be provided between the base slab and side wall with PVC water stops.

(h) Any natural water flow during rainy season in the site shall be suitably diverted at contractor's cost without affecting work.

23.4.0. AUTO-TRANSFORMER FOUNDATIONS:

(a) It shall consist of a RCC soak pit having pedestal for supporting the transformer and its cooling bank etc., The size of the soak pit shall be 1.0 M bigger all round than the plan size of transformer including its cooling bank. The depth of soak pit shall be adequate to accommodate the full quantity of oil contained in the transformer plus 50% of mulier water in voids of gravel filling inside the soak pit.

(b) The gravel size to be filled in the soak pit shall be of 60 mm to 40 mm nominal size and it shall be ensured that 40% of voids are available in the gravel filling after its packing in soak pit. The top of the gravel filling inside the soak pit shall be 200 mm below the top of the rail. The arrangement of auto-transformer foundation shall be furnished by the tenderer.

(c) Central oil collecting pit:

A common R.C.C. central oil collecting pit shall be provided for all the auto-transformers. This pit shall be closed type and water proof construction with necessary manholes and rungs etc., for maintenance purposes. The soak pits of auto-transformers shall be connected to this central oil collecting pit through underground R.C.C. pipes and man holes.

The size of the oil collecting pit shall be adequate to accommodate the full quantity of oil contained in the largest transformer including rain water and mulsier water required for the biggest transformer and to ensure that no oil/mulsier water remains in the transformer soak pit/drain pipes and the level of soak pit shall be accordingly decided.

The size of R.C.C. pipes to be used for connecting the soak pit of the transformers to the central oil collecting pit shall not be less than 300 mm diameter and shall be of class NP4 conforming to IS:458 (latest) as per recommendations of Tariff Advisory committee.

The central oil collecting pit shall have provision for installing 2 Nos. of 100% capacity sump pumps with all accessories like suction and discharge pipes for transferring discharge to oil water separator such that each pump can pump oil/rain water/mulsier discharge of auto-transformer of biggest transformer in the switch-yard transformer in the switchyard. The suitable size oil-water separator shall be designed and provided by the contractor in a manner that oil would be separated from water and same shall be retained in oil water separator while water shall be disposed off to the nearest storm water drain. The oil water separator shall also be of R.C.C. construction. Design of transformer data etc., to be furnished by the purchaser as per the list in Clause 1.3/21.2 of Section, General of civil works.

23.5.0. DRAINAGE OF SWITCHYARD AREA:

a) Suitable drainage arrangement shall be designed and provided by the contractor to drain off the rain water quickly and efficiently from switchyard area. For this purpose, the yard shall be sloped away from control building and also from cable trenches, so as to prevent ingress of rain water into them. The arrangements of drainage provided shall be connected at suitable points to drainage system for rest of the switchyard (or the water shall be drained off to suitable outlet as approved by the purchaser).

b) All surface drains shall be constructed with RR masonry in cement-sand mortar 1:5 (1 cement : 5 Coarse sand) and these shall be plastered inside with cement sand mortar 1:3 (1 cement : 3 fine sand). The thickness of plaster shall be not less than 12 mm. Layers of suitable thickness of CNS material shall be provided around the drains to protect the walls of drains from the swelling pressure of black cotton soil. The longitudinal slope of drains shall be so decided that there is no accumulation of silt in the drains and rain water is disposed off as quickly as possible without causing any flooding in the switchyard area. However, the slope of drains shall not be lesser than 1:1000.

c) The minimum width of any drain shall not be less than 450 mm and depth of drain shall not be less than 300 mm.

23.6. ROADS IN SWITCHYARD AREA:

a) The tentative locations of the roads in switchyard areas have been shown in the tender drawings. These roads shall be kept 150 mm above the finished ground level of the yard.

b) All roads shall be flexible bituminous pavement except the Transformer Gantry road which shall be of R.C.C. construction as per the details shown in the tender drawings. The top of the rail shall flush with top of the road.

The grade of concrete to be used for road-cum-rail track shall M20 conforming to IS:456 – 2000 and this Specification.

c) The rails for transformer plinth to be used shall be as indicated by the tenderer to suit the transformer manufacture's specification.

23.7. FINAL GRANDING AND METALLING OF SWITCHYARD:

a) The site shall be graded to the required level and slope soon after the completion of all the foundations, cable trenches, other under ground facilities and grounding network etc., Before laying the layers of murrum and metal, anti-weed treatment shall be given to soil as per specification. The yard shall be then filled with 100 mm thick (compacted thickness) layer of murrum of approved quality to the full satisfaction of the purchaser. Over the layer of murrum, 250 mm thick (compacted thickness) HBG metal of 25 mm size (single size ungraded) complying to the Indian Standard shall be laid as a final finish.

23.8. GRADE OF CONCRETE:

a) All structural concrete shall be of grade M-20 conforming to IS:456 – 2000 and this Specification unless stated otherwise. The lean concrete under structural concrete shall be of nominal mix and of grade M-10 (1:3:6) unless specified otherwise. Cement shall be ordinary Portland cement as per IS 269 or IS 8112.

b) The thickness of lean concrete below structural concrete shall not be less than 75 mm.

23.9. DESIGN LOADINGS:

23.9.1. All foundations, structures, cable trenches, sump pits, drains, central oil collecting pit, culverts, road-cum-rail track and all other civil facilities in the scope of this contract shall be designed for the worst combination of following loads as applicable.

a) Dead Loads: Self weight foundation, structures, weight of equipment including impact/vibration loads.

b) Live Loads: The live loads shall be considered as per IS:875 (latest) Live load for control room building shall be taken as 1000 kg/sq.m.

c) Wind Loads: Wind Loads shall be considered as per IS:875 & IS:802 as applicable.

d) Seismic Loads: Seismic loads be taken as per ;IS:1893 (latest).

e) Loads due to broken wire conditions and short circuit forces shall be considered as per design of galvanized steel structures.

f) All under ground facilities like cable trenches, sump pits, Oil collecting pit, soak pit of transformer, drains etc., shall be designed for earth pressure including swelling pressure and sub-soil water pressure under worst conditions likely to be encountered in the life of structures. In addition, a surcharge load of 2.5 tonne per sq.m (Minimum) or actual whichever is more shall also be considered in the design.

g) R.C.C. Pre-cast covers of cable/pipe trenches shall be designed for a live load of 1000 kg/sq.m Trenches at road crossings shall be designed for class 'A' loading as per relevant IRC codes.R.C.C cast-in-situ slab over cable duct at suitable interval for A,B,C duct shall be provided as directed by Engineer at site.

h) Sump pits & Oil collecting pit etc., which are covered at top, shall be designed for a live load of 500 kg/sq.m in addition to equipment loads and maintenance loads, if any.

i) R.C.C. Road-cum-rail track, jacking platforms, anchor blocks etc shall be designed for the load of heaviest transformer.

j) All culverts shall be designed for class 'A' loading except for culverts which may be required for road-cum-rail track. These shall be designed for the load of heaviest transformer and checked for class 'A' loading.

23.9.3. Design of concrete mix along with quality control of all concrete items such as concrete grades, placing formwork reinforcements, workmanship etc., shall conform to IS:456. Sampling testing and consistency tests of concrete shall be done in accordance with IS:516 and IS:456/

23.9.4. The water proofing admixtures conforming to relevant Indian Standards shall be used in concrete work of cable trenches (except R.C.C. pre-cast covers), as per the direction of the manufacturer or as directed by the purchaser.

24.0. DETAILED DESIGN & ENGINEERING INCLUDING PREPARATION OF CONSTRUCTION DRAWINGS:

24.1. The successful bidder shall submit his detailed schedule for submission of design and drawings and construction programme within 14 days after LOI is issued to him so as to match the completion period of contract for successful commissioning of 400 KV SS.

24.2. After award of contract, successful bidder shall be required to submit the designs, layout & construction drawings, detailed working drawings along with bar bending schedule for all foundations, cable/pipe trenches and all other structures and items covered under the scope of this. This shall be submitted progressively and in no case the 1st set of design and drawings shall be submitted later than 30 days from the date of issue of letter of acceptance to the contractor.

24.3. The design drawings shall consist of general arrangement drawings showing location of tower and various equipment foundations along with cable trenches, roads, road side drains and drains inside switchyard, transformer foundations, central oil collecting and sump pits, oil water separator and all other related items/services required for the project. Subsequently detailed drawings along with design calculations and bar bending schedule for all foundations and all other civil works shall be submitted by the contractor for approval.

24.4. Detailed dimension drawings and design calculations for all civil and structural works shall be submitted to the purchaser for scrutiny and approval. All designs and drawings shall be got approved within a period of four months from the date of issue of letter of acceptance.

24.5. Six copies of all designs and drawings along with bar bending schedule for all type of foundations, trenches, roads drains and other related items/services required for the project shall be submitted by the contractor for approval in the first instance. The drawings and designs thus submitted shall be scrutinized by the purchaser and comments/modifications required shall be communicated to the contractor. One copy each of the drawings and designs connected shall be returned to the contractor, who shall incorporate all the corrections/modifications and resubmit six (6) copies each of the drawings and designs to the purchaser for re-examination and approval. In case the approval to the designs/drawings is subjected to any modification, additions, alterations, the contractor shall carryout all such changes and re-submit six (6) sets of the revised drawings and calculations for final approval.

24.6. After drawings and design calculations have been accorded final approval, the contractor shall submit five (5) prints and one (1) reproducible films and one set in compact Disc of such approved design and detailed working drawings for distribution purpose. In addition, the contractor shall be required to furnish two (2) prints of all final drawings including drawings furnished by the purchaser and one (1) reproducible films and one set in Compact disc as actually

constructed and marked 'As Built' after completion of all works and acceptance of the same by purchaser.

24.7. The construction work shall start only after the approval to the design and construction drawings is accorded by the purchaser. No construction shall commence prior to obtaining of written approval from the purchaser.

24.8. Any approval which the purchaser may have given to the designs and drawings shall not relieve the contractor of his responsibilities for the correctness of the designs and drawings and for execution of the work in accordance with the terms of the specifications. Detailed drawings approved by the purchaser are to be acted upon where they differ from the general drawings.

Detailed drawing for rainwater harvesting / diversion to low lying area within SS premises shall be submitted by the contractor with the available items in the schedule.

24.9. CONTRACT DRAWINGS:

The drawings bearing the purchaser's approval or drawings corrected in accordance with the comments of the purchaser shall be deemed to be contract drawings and no variation there from shall be taken without the purchaser written consent.

25.0. SITE PREPARATION:

25.1. The contractor shall furnish all labour, equipments and materials except cement required for complete execution of the work in accordance with the approved drawings and as described herein.

25.2. Reference points and Bench Mark:

Purchaser shall give one reference Bench Mark in the near vicinity of proposed site. The contractor shall carefully maintain and protect all Bench Marks and reference points. Necessary survey work shall be conducted by the contractor for fixing up the exact location of different structures, foundations, trenches and all other items covered in the scope of this contract.

25.2.0. Reference points and Bench Mark.

Owner shall give one reference Bench Mark in the near vicinity. The contractor shall carefully maintain and protect all Bench marks and reference points. Necessary survey work shall be conducted by the contractor for fixing up the exact location of different structures, foundations, trenches and all other items necessary for completion & commissioning of the substation.

26.0.0. EARTH WORK:

This specification deals with earth work i.e. excavation & back filling in all locations covered under this tender.

26.2.0. Excavation:

26.2.1. This section of the Specification covers excavation for structure, buildings, foundations, tunnels, ducts, trenches, drain channels and underground facilities and retaining walls as shown in the approved drawings and as specified herein.

Excavation in all kinds of soil, dewatering, removal of excavated earth from foundations, trenches, back filling lean concrete under foundations and trenches for all tower structures, equipment and pipe supports, control cubicles of equipments, bus post supports, bay marshalling kiosks, transformers, rail-cum roads with diamond crossings, cable trenches.

26.2.2. The contractor shall be responsible for the true and proper setting out of the work in relations to original points, lines and levels of reference and for the correctness of the levels, dimensions and alignment of all parts of the work and for the provision of all necessary instruments, appliances and labour in connection therewith. If at anytime during the progress of the work any error appears or arises in the position of levels, dimensions, or alignment of part of the work the contractor on being required to make-good shall at his own expense rectify such errors to the satisfaction of the Engineer-in-charge. The checking shall not in any way relieve the contractor or his responsibilities.

26.2.3. The contractor shall lay out one or more permanent Bench Marks in some control place before the start of the work, from which all important levels for the excavation will be set. The contractor shall provide all labour and materials for setting levels at his own cost.

These permanent Bench Marks shall consist of masonry pillars with top neatly plastered and horizontal as per the approval of Engineer-in-charge. Bench Marks shall be well connected with Grid Triangular system of any other Bench Mark approved by Engineer-in-charge.

26.3.0. Drainage in the vicinity of excavation:

The contractor shall control the grading in the vicinity of all excavation so that the surface of the ground will properly sloped or clicked to prevent surface water from running into the excavated areas during construction.

26.4.0. Excavation shall include blasting/ drilling with jack hammer /compressor if required and the removal of all materials required to execute the work properly

and shall be made with sufficient clearance to permit the placing, inspection and setting of forms and completion of all works for which the excavation was made.

26.5.0. Sides and bottoms of excavations shall be cut sharp and true. Undercutting shall not be permitted. Earth sides of excavation shall not be used in lieu of form-work for placement of concrete unless authorized.

26.6.0. When machines are used for excavation the last 300 mm before reaching the required level shall be excavated by hand or by such equipment that will leave the strata at the required final level, in its natural condition.

26.7.0. Suitability for bearing of the bottoms of excavation shall be determined by the Engineer-in-charge.

26.8.0. The bottom of excavation shall be trimmed to the required levels, with a tolerance of + 100 mm and when carried below such levels by error, shall be brought to level by filling with lean concrete as specified at the contractor's cost. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level.

26.9.0. The contractor shall be responsible for assumptions and conclusions regarding the nature of materials to be excavated and the difficulty of making and maintaining the required excavations and performing specifications. Cofferdams, sheeting, shoring bracing, draining, dewatering etc., shall be furnished and installed as required and the cost thereof shall be included in the unit rate quoted in bid. The contractor shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the contractor shall remove all slipped material from the excavated pit if it can be done with safety for the work and structure, as approved by the Engineer. However, no extra costs shall be claimed for material not salvaged.

26.10. All excavations for installation of underground facilities, such as piping, trenches, ducts, etc., shall be open cuts.

26.11. Excavations for foundations shall be carried to an adequate depth below the bottom of structural concrete and then be brought to the required level by sand filling and/or placing lean concrete M10 Grade mix with aggregate of 20 mm /40 mm as per specification.

26.12. Where excavation requires cofferdam bracing sheeting or shoring etc., the contractor shall submit to the purchaser, drawings arrangement and details of proposed installation and shall not proceed until he has received approval from the purchaser. Prior approval of the Engineer shall be obtained by the contractor, in each individual case for the method he proposes to adopt for the excavations including dimension, side slopes, dewatering, disposal, etc., These approvals however, shall not in any way make the Engineer responsible for any consequent loss or damage or absolve the contractor.

26.13. All excavations shall be come to the minimum dimensions as required for safety and working facility and in the most expeditious and efficient manner. As the excavation reaches the required dimensions, lines levels and grades, the work will be checked by the engineer thoroughly and the balance work will be carried out carefully to avoid any over-excavation. On completion, the work will be finally checked and approved by the Engineer.

26.14. All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surfaces shall be removed, if in the opinion of the Engineer they are likely to be a hindrance to the workers.

26.15. All loose boulders, semi-detached rocks, not directly in excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment of the work etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to render unstable or unsafe the portion which was originally sound and safe. Any materials not requiring removal as contemplated in the work, but which in the opinion of the Engineer, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Engineer.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

26.16.1. In certain cases, where deterioration of the ground, upheaval, slips, etc., are expected the Engineer may order to suspend the work at any stage and instruct the contractor to carry out the balance work just before the foundation work of the structure can be started. No extra amount will be paid to the contractor for such unavoidable temporary suspension of work.

26.16.2. Where the excavation is to be carried out below the foundation level of an adjacent structure, the precautions to be taken such as under priming, shoring and shuttering etc., shall be determined by Engineer-in-charge. No excavation shall be done unless such precautionary measures are carried out as per direction of Engineer-in-charge. The payment for such precautionary measures are deemed to have been included in the bid price and no extra amount will be paid on any account.

27.0. DESIGN LOADS:

Building structures shall be designed for the most critical combinations of dead loads, super-imposed loads, equipment loads, crane load, wind loads, seismic loads and temperature load.

Dead loads shall include the weight of structures complete with finishes, fixtures and partitions and should be taken as per IS 875 –Part I.

Super-imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks/hangers and erection, operation and maintenance loads. Equipment loads shall constitute, if applicable, all load of equipments to be supported on the building frame and should be taken as per IS 875 –part II

For crane loads an impact factor of 25% -(page 15 of IS 875 Part II)and lateral crane surge of 10% (lifted weight + weight of crane) shall be considered in the analysis of frame according to provisions of IS:875.-Part II The horizontal surge shall be 5% of the static wheel load.(page 16 of IS 875 Part II)

The wind loads shall be computed as per IS 875, Seismic Coefficient method shall be used for the seismic analysis as per IS 1893 Part I with importance factor 1.5.

For temperature loading, the total temperature variation shall be considered as 2/3 of the average maximum annual variation in temperature. The average maximum annual variation of temperature for the purpose shall be taken as the difference between the mean of the daily minimum temperature during the coldest month of the year and mean of daily maximum temperature during the hottest month of the year. The structure shall be designed to withstand stresses due to 50% of the total temperature variation.

Wind and Seismic force shall not be considered to act simultaneously.

Floors shall be designed to carry loads imposed by equipment cables piping travel of maintenance trucks and equipment and other loads as per relevant IS. Cable and piping loads, shall also be considered additionally for floors where these loads are expected.

In addition, beams shall be designed to carry loads imposed by equipment, cables piping travel of maintenance trucks and equipment and other loads associated with building. Floors shall be designed for live loads as per relevant IS cable and piping loads, shall also be considered additionally for floors where these loads are expected.

For consideration of loads on structures, IS:875, the following minimum superimposed live loads shall, however, be considered for the design.

a	Roof	1.5 KN/M2 0.75 KN/M2		For accessible roofs for in-accessible roofs.
b	RCC-Floor	(i) 5 KN/M2 (ii) 10 KN/M2		For offices. For equipment floors or (minimum) actual require

				ment, if higher than 10 KN/M2 based on equipment component weight and layout plans.
c	Stairs & balconies		5 KN/M2	
d	Toilets		2 KN/M2	
e	Chequered plate floor		4 KN/M2	
f	Walkways.		3 KN/M2	

Any additional load coming in the structure shall be calculated as per IS : 875/ Part II

28.0. SUBMISSION:

The following information shall be submitted for review and approval to the purchaser.

- 28.1. Design criteria shall comprise the codes and standards used, applicable climatic data including wind loads, earthquake, factors maximum and minimum temperatures applicable to the building locations, assumptions of dead and live loads, including equipment loads, impact factors, safety factors and other relevant information.
- 28.2. Structural design calculations and drawing (including construction/fabrication) for all reinforced concrete and structural steel structures.
- 28.3. Fully dimensioned concept plan including floor plans, cross sections, longitudinal sections, elevations and perspective view of each building. These drawings shall be drawn at a scale not smaller than 1:50 and shall identify the major building components.
- 28.4. Fully dimensioned drawings showing details and sections drawn to scales of sufficient size to clearly show sizes and configuration of the building components and the relationship between them.
- 28.5. Product information of building components and materials including walls partitions flooring ceiling, roofing, door and windows and building finishes.
- 28.6. A detailed schedule of building finishes including colour schemes.
- 28.7. A door & window schedule showing door types and locations, door look sets and latch sets and other door hardware.

29.0. Internal finish Schedule in given Table-1 below:

TABLE – 1

Sl. No.	Location	Flooring	Wall	Ceiling	Door, windows, Ventilators.
01.	Control Room PLCC & AC Equipment ,office room.	virtified of non slippery type tiles 600x600mm over cement mortor 1:3 25 mm thick M10 Grade 100 mm concrete.	Emulsion paint two coats over prime coat.	2 coats using white cement for ceiling in all floors and exposed faces of beams and False ceiling and under deck.	Anodized Aluminium doors /Steel doors ,Alu window Sliding ,Steel windows ,Alu Ventilators as per drawing.and sections as per IS 733 & 1285 and other relavent ISS
02	Battery room	Acid Resistant Tiles 25 mm thick of approved make	DADO acid resistant tile 2.1 m high Acid resistant paint above 2.1 m upto ceiling.	Acid resistant paint	Alu.door & Exhaust Fan as per drg.
03.	Toilet & Rest room	Non slippery tiles of approved make	Dadoing with glazed tile 2.1 m high	White wash	PVC door as per Teak wood frame flush door shutter with anodized.

30.1.0. All the equipment foundations and structural members shall be designed as per the relevant clauses of this specification and IS codes. Arrangement shall be made for collection of split oil from oil diesel/operated equipment, in the form of drain and sump along the periphery.

30.2.0. Doors and windows shall be provided as indicated in drawings.

31.0. BUILDING STORM WATER DRAINAGE FOR ALL BUILDINGS:

The building drain shall be provided for the collection of storm water from the roofs. This water shall be collected in junction boxes and these boxes shall drain to the main drainage system of the station.

PVC rain water down corners water tight joints shall be provided to drain off the rain water from the roof. These shall be suitably concealed with masonry work of cement concrete or cladding material. The number and size of down corners shall be governed by IS 1742 and IS 2527.

All drains inside the buildings shall have minimum 40 mm thick grating covers and in areas where heavy equipment loads would be coming pre cast RCC covers shall be provided in place of steel grating.

For all buildings, suitable arrangement for draining out water collected from equipment blow down, leakages, floor washings fire fighting etc., shall be provided for each floor.

32.0. MISCELLANEOUS GENERAL REQUIREMENTS:

32.1.0. Dense concrete with controlled water cement ratio as per IS-code shall be used for all underground concrete structures such as pump house, tanks, water retaining structures, cable and pipe trenches etc., for achieving water-tightness.

32.2.0. All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230 mm.

32.3.0. All steel sections and fabricated structures which are required to be transported on sea shall be provided with anti corrosive paint to take care of sea worthiness.

32.4.0. All mild steel parts used in the water retaining structures shall be hot-double dip galvanized. The minimum coating of the zinc shall be 750 gm/sq.m. for galvanized structures and shall comply with IS:2629 and IS:2633. Galvanizing shall be checked and tested in accordance with IS:2633.

32.5.0. A screed concrete layer not less than 100 mm thick and of grade not weaker than M 10 conforming to IS:2000 shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structures.

- a. Fly ash Bricks having minimum 75 kg/cm² compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 75 kg/cm² compressive strength before submitting his offer.
- b. Angles 50 x 50 x 5 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of machines supporting covers, supporting edges of manhole precast over and any other place where breakage of corners of concrete is expected.

32.6.0. Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc., as per IS:6313 and other relevant Indian Standards.

SECTION : STRUCTURES:

33.00. GENERAL:

33.1.0. The scope of the specification covers design (excepting design of those structures which have been standardized and enclosed with the specification/to be provided by the purchaser), fabrication, proto assembly, supply and erection of galvanized structures for towers, girders, lightning masts and equipment support structures, shall be lattice structures fabricated from structural steel conforming to IS 2062 (latest), all equipment support structures except 400/230 KV CT shall be fabricated from GI pipe conforming to YSt 22 (kg/sq.cm) or of higher grade as per IS 806. Support structure for circuit breaker/any other structures & equipments are not standardized and shall be designed by the contractor. Foundation for all structures and equipments shall be designed by the contractor.

33.2.0. It is the limit of the purchaser to provide structures which allow interchangeability of equipments at a later stage. Accordingly, equipment support structure standardization has been carried out with the provision of stool. Stools may be provided between the equipment and its support structure to match the bus bar height. The top of the stool shall be connected to the equipment and the bottom of the stool shall be connected to the support structure.

33.3.0. The scope shall include supply and erection of all types of structures including bolts, nuts, washers, hangers, shackles, clamps anti climbing devices, bird guards, step bolts, inserts in concrete, gusset platters, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates, ground mounted marshalling boxes (AC/DC marshalling boxes and equipment control cabinets), structure mounted marshalling boxes and any other items as required to complete the works.

33.4.0. The connection of all structures to their foundations shall be by base plates and embedded anchor/foundation bolts of EN 8 steel. All steel structures and anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be atleast 0.610 kg/sq.m for anchor bolts/foundation bolts and for structural members. One additional nut shall be provided below the base plate which may be used for the purpose of leveling.

34.0. DESIGN REQUIREMENTS FOR STRUCTURES NOT COVERED IN STANDARDISED LIST:

34.1. For materials and permissible stresses IS:802, part-I, Section-2 shall be followed in general. However, additional requirements given in following paragraphs shall be also considered.

34.2. Minimum thickness of galvanized lower member shall be as follows:

Members	Minimum Thickness (mm)
Leg members, ground wire peak Members/main members.	5
Other members	4
Redundant members	4.

34.3. Maximum tenderness ratios for leg members, other stressed members and redundant members for compression force shall be as per ;IS 802.

34.4. Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.

34.5. The minimum bolt diameter shall be 16 mm.

34.6. Step Bolts:

In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Each tower shall be provided with step bolts not less than 16 mm diameter & 175 mm long spaced not more than 450 mm apart, staggered on faces on one leg extending from about 0.5 meters above ground level to the top of the tower. The step bolt shall conform to IS 10238. Ladders on towers with lighting appliances shall be provided with safety guards.

34.7. DESIGN CRITERIA:

- a) All structures shall be designed for the worst combination of dead loads, lives loads, wind loads as per code IS:875 IS:802, seismic forces as per code IS:1893 (latest) importance factor of 1.5, loads due to deviation of

conductor, load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including "snatch" in the case of bounded conductors etc., Short circuit forces shall be calculated considering a fault level of 40.0 KA. IEC 865 may be followed for evaluation of short circuit forces.

- b) Switchyard gantry structure shall be designed for the two conditions i.e., normal condition and short circuit condition. In both conditions the design of all structures shall be based on the assumption that stringing is done only on one side i.e. all the three (phase) conductors broken on the other side. Factor of safety of 2.0 under normal conditions and 1.5 under short circuit condition shall be considered on all external loads for the design of switchyard structures which are of lattice type.
- c) Vertical load of half the span of conductors/string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with tools shall be considered as 150 kgs for the design of structures.
- d) Terminal/line take off gantries shall be designed for a minimum conductor tension of 4 metric tones per phase for 400 KV and 2 metric tones per phase for 220 KV, 1 tonne per phase for 132 KV or as per requirements whichever is higher. The distance between terminal gantry and dead end tower shall be taken as 200 metres. The design of these terminal gantries shall also be checked considering +/- 30 deg. Deviation of conductor in both vertical and horizontal planes. For other gantries the structural layout requirements shall be adopted in design.
- e) The girders shall be connected with lattice columns by bolted joints.
- f) All pipe support used for supporting equipments shall be designed for the worst combination of dead loads, erection load. Wind load/seismic forces, short circuit forces and operating forces and operation forces acting on the equipment and associated bus bars as per IS:806. the material specification shall be as per IS:1161 read in conjunction with IS:806.
- g) If luminaries are proposed to be fixed on gantries/towers, then the proper loading for the same shall be considered while designing. Also holes for fixing the brackets for luminaries should be provided wherever required.
- h) Foundation bolts shall be designed for the loads for which the structures are designed.

Lightning Mast shall be 50 m in height (47.5 m lattice structure plus 2.5 m pipe) and designed for diagonal wind condition. Lightning masts shall be provided with a structural steel ladder within its base upto height of 25 metre. The ladder shall be provided with protection rings. Two platforms

shall be provided one each at 12.5 m and 25.0 m height for mounting off lightning fixture. The platforms shall also have protection railing. The details of lightning fixtures would be as per the approved drawings.

35.0. DESIGN DRAWINGS, BILL OF MATERIALS AND DOCUMENTS:

35.1. The contractor shall furnish design, drawing and BOMs to the OWNER after award of the contract. However, contractor shall have to prepare and submit any other drawings, bill of materials (BOM) additionally required during design and construction stage which the OWNER feels necessary. In case OWNER feels that any design drawing, BOM are to be modified even after its approval, contractor shall modify the designs and drawings and resubmit the design drawing, BOM as required in the Specification.

35.2. The fabrication drawings to be prepared and furnished by the Contractor shall be based on the design approved by the OWNER or standard drawing provided. These fabrication drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, lacing details, weld sizes and lengths. Bill of materials in the proforma approved by the OWNER, bolt details and all customary details in accordance with standard structural engineering practice whether or not given by the OWNER shall be indicated.

35.3. The fabrication work shall start only after the final approval to the Design and Design drawing is accorded by the OWNER. The design drawing should indicate not only profile, but section, numbers and sizes of bolts and details of typical joints.

35.4. Such approval shall, however, not relieve the Contractor of his responsibility for the safety of the structure and good connections and any loss or damage occurring due to defective fabrication, design or workmanship shall be borne by the Contractor.

36.0. FABRICATION OF STEEL MEMBERS:

36.1. The fabrication and erection works shall be carried out generally in accordance with IS 802. A reference however may be made to IS 800 in case of non-stipulation of some particular provision in IS 802. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.

37.0. PROTO – ASSEMBLY:

(i) The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified camber, if any, is provided. In order to minimize distortion in member the component parts shall be positioned by using the clamps, clips, dogs, jigs and other suitable means and fasteners (bolt and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, paralleled and tapered drifts shall be used to align the part so that the bolts can be accurately positioned.

(ii) Sample towers, beams and lightning masts and equipment support structures shall be trial assembled in the fabrication shop and shall be inspected and cleared by the contractor based on the design approval accorded by OWNER before mass fabrication.

Pursuant to above the B.O.Ms along with proto-corrected fabrication drawing shall be prepared and submitted by the main vendor to OWNER as document for information. Such BOM, which shall be duly certified by the main vendor for its conformity to the approved design, shall be the basis for OWNER to carry out inspection.

38.0. BOLTING:

- (i) Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.
- (ii) All steel items, bolts, nuts and washers shall be hot dip galvanized.
- (iii) 2.0% extra nuts and bolts shall be supplied for erection.

39.0. WELDING:

The work shall be done as per approved fabrication drawings clearly indicate various details of joints to be welded, type of weld, length and size of weld, whether shop or site weld etc., Symbols for welding on erection and shop drawings shall be according to IS:813. Efforts shall be made to reduce site welding so as to avoid improper joints due to constructional difficulties.

40.0. FOUNDATION BOLTS:

40.1. Foundation bolts for the towers and equipment supporting structures and elsewhere shall be embedded in first stage concrete while the foundation is cast. The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate.

40.2. the contractor shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the towers/structures plumb.

40.3. All foundation bolts for lattice structure, pipe structure are to be supplied by the contractor as per schedule.

40.4. All foundation bolts shall be fully galvanized so as to achieve 0.61 kg per sq.m of Zinc Coating as per specification.

40.5. All foundation bolts shall conform to IS:5624 but the material, however shall be MS/EN8 as the case be and conforming to IS:2062.

41.0 STABILITY OF STRUCTURE:

The supplier shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracing and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

42.0. GROUNDING:

The method of grouting the column bases shall be subject to approval of OWNER and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base. The contractor will be fully responsible for the grouting operations.

43.0. GALVANISING:

43.1. All structural steel works and pipe supports shall be galvanized after fabrication as per relevant ISS specification.

43.2. The contractor shall be required to make arrangement for frequent inspection by the OWNER as well as continuous inspection by a resident representative of the OWNER if so desired for fabrication work.

44.0. TOUCH-UP PAINTING:

The touch up primers and paints shall consist of Red Oxide/Zinc chromate conforming to the requirements of IS:2074 with a pigment to be specified by the OWNER

45.0. INSPECTION BEFORE DESPATCH:

Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by the OWNER or his authorized representative as satisfactory before it is dispatched to the erection site. Such certification shall not relieve the contractor of his responsibility regarding adequacy and completeness of fabrication.

46.0. TEST CERTIFICATE:

Copies of all test certificates relating to material procured by the contractor for the works shall be forwarded to the OWNER.

47.0. ERECTION:

The contractor should arrange on his own all plant and equipment, welding set, tools and tackles, scaffolding, trestles equipments and all other accessories and ancillaries required for carrying out erection without causing any stresses in the members which may cause deformation and permanent damage.

48.0. SAFETY PRECAUTIONS:

The contractor shall strictly follow at all stages of fabrication, transportation and erection of steel structures, raw materials and other tools and tackles, the stipulations contained in Indian Standard Code for Safety during erection of structural steel works IS:7205.

49.0. STANDARD GANTRY AND EQUIPMENT SUPPORT STRUCTURES:

The OWNER has standardized certain equipment and gantry structures. Copies of the drawings of such structures are enclosed, which also indicate main parameters for which the designs have been made. It is intended that only standard structures shall be used in the switchyard to the maximum extent. However if necessary, as per site requirement, different designs may be adopted. Structures other than those standardized, if required, are to be designed, supplied and erected as described in proceeding paragraphs, without any extra financial implication to the OWNER

49.2. All tests mentioned in standard field quality plans have to be carried out and conformity of materials and workmanship shall be ascertained.

50.0. DESIGN CALCULATION AND DRAWINGS:

On award of contract, the successful bidder shall submit design and drawings of all structures and foundation for scrutiny and approval.

After approval of design, drawings and bill of materials the successful bidder shall furnish five (5) copies of the following to the purchaser for necessary distribution along with the original polyester tracing paper of 50 microns thickness and in compact disc within fifteen (15) after approval of drawings.

- a) Detailed design calculations along with drawings of structures and foundations.

- b) Detailed structural drawings indicating section size, length of member, size of plate along with hole to hole distance, joint details etc.,
- c) Bill of materials indicating cutting and bending details against each member.
- d) Shop drawings showing all details relevant to fabrication.

NOTE:

1. The contractor shall submit five (5) copies of the above drawings for purchaser's approval. The contractor shall clearly indicate on each drawing TANTRANSCO Specification No. and name of work.
2. The design and drawings covered above shall be approved/commented by the purchaser as the case may be within thirty (30) days of receipt of design/drawings in TANTRANSCO (SE/Transmission Office). If the designs/drawings are commented by the purchaser, the contractor shall submit revised design/drawings duly incorporating all comments within (15) days of the date of issue of comments.

51.0. TESTS:

51.1. All the tests as per IS:2633 shall be carried out for the earthing conductors.

51.2. AIR CONDITIONING:

01.	Area to be air-conditioned	Control room
02.	Location of A/c. plant	In the ground floor as shown in the drawing .
03.	Ambient temperature	42 degree C to 45 C
04.	Inside room temperature to be maintained.	As per control panel requirement
09.	Roof	12.5mm Gypsum board False ceiling and under deck insulation with thermo cool sheets shall be provided by supplier.
10.	Exposed Glass	Venetian binds shall be provided by the supplier.
11.	Type of Cooler.	Dry Type.
12.	General	The air-conditioning shall be designed with package units only. The air-conditioning system should be complete with compressors, evaporator,

		condenser air handling fan, blowers, filters, cooling coil, refrigerant piping motor, control switches, vibration isolator, first charge, humidifier assembly hearing coil, supply air Plenums.
13.	General	Air distribution shall system consist of galvanized steel sheet ducting, supply air diffusers, return air grilles, acoustic insulation for ducting complete supports and wooden frame work for mounting diffuser and grilles. Thermal insulation shall be provided for drain line from drain pan of air handling units to floor drain and refrigerant piping.
14.	Calculations	The contractor shall submit detailed calculation for the capacity (Tonnage) offered. Tentative quantities of material and labour are provided in the schedules.

52.0. YARD LIGHTING:

The contractor shall design the switchyard lighting for the entire substation area. The recommended levels of illumination is

General horizontal : 21.52 Lux.

Specific vertical (on disconnects) : 21.52 Lux.

These levels of illumination shall be designed to be achieved by using CFL bulbs. The lighting masts in the substation have lightning platforms for mounting of these lamps at 12.5 metre and 25 metre levels. These platforms have to be made use of for mounting the lightning fixtures. The contractor can propose separate masts for the 110 KV yard lights, 230 KV yard lights and where additional masts are required for 400 KV yard lights. These masts shall be designed by the contractor only after detailed discussion with the purchaser regarding the height, location and numbers etc, and the design shall be submitted within 60 days of award of contract.

The CFL bulb fitting along with fixtures shall be procured by the contractor erected and commissioned with necessary lamp control switches and switch boxes. The brand names of the fittings and lamps should be got approved before ordering. Tentative quantity has been indicated in the schedule.

53. BUS STRINGING:

53.1. INSULATOR ASSEMBLY:

The insulators shall be thoroughly cleaned and examined for any cracks and damages before assembly and erection. The IR values should be measured and in case of any abnormality, the insulators should be discarded. Care should be taken to handle the insulators and corona control rings. Any damages to the insulators and fitting assemblies due to, mishandling shall be to the account of the contractor. Wherever locking arrangements have to be provided with M pins, R pins or lock nuts, the same shall be done in the proper manner as per standard erection practices.

53.2. CONDUCTOR HANDLING:

The Moose conductor should be handled with extreme care without causing even the slightest scratches. Pulleys supported on trustles and the horse stands should be used for unwinding of conductor. The conductor should never be permitted to come in contact with the ground. Care should be taken to avoid formation of Kinks while unwinding the conductor.

53.3. STRINGING OF CONDUCTOR:

Pre tensioning of conductor shall be done before stringing. Continuous run of conductor for the main bus for the entire Nos. of bay shall be provided.

While tensioning of conductor, necessary temporary stays for the end girders shall be provided to avoid any deformation of the girders and towers Sag Compensating Springs, spacers etc., with are required to be mounted at the location indicated in the electrical drawings shall be erected as per manufactures recommendations/erection practices.

54.0. CONTROLLED CONCRETE:

a. General:

Controlled concrete shall be used on all concrete works, except where specified.

b. Mix Proportions:

The mix proportions for all grades of concrete shall be designed to obtain strength corresponding to the values specified in IS:456 for respective grade of concrete. Preliminary tests, as specified in the IS code or as required by the Engineer-in-charge, shall be carried out sufficiently ahead of the actual commencement of the work with different grades of concrete made from representative sample of aggregates and cement expected to be used on the job

to ascertain the water cement ratio required to produce a concrete having specified strength and sufficient workability to enable it to be well consolidated and to be worked into comers of shuttering and around.

54.3. MIX DESIGN CRITERIA:

Concrete mixes will be designed by the contractor to achieve the strength, durability and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations.

Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

- a) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.
- b) The various fractions of coarse and fine aggregate should be mixed in such a proportion as to produces the best possible combined internal grading giving the densest and most workable mix.
- c) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete by the Engineer. The contractor will strictly abide by the same in his design of concrete mix installation.

Notwithstanding anything mentioned to various tables given in IS:456 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, the following tables in the specification are included. For identical condition if values given in the tables shown herein below are different from those mentioned in IS:456, the values as indicated in the table shown herein below shall prevail.

54.4. TABLE – I:

Grade of concrete	Specific characteristic compressive strength of 150 mm cubes at 28 days conducted in accordance with
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	IS:516 (All values in N/sq.mm)
M.10	10
M – 15	16
M – 20	20

54.5. TABLE – II:

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREE OF WORKABILITY WITH DIFFERENT VALUES OF WATER CEMENT RATIO.

(FOR GUIDANCE ONLY)
CEMENT/TOTAL AGGREGATE RATIOS.

Workability	Water Cement Ratio	Ratio by weight of cement to Gravel Aggregate		Ratio by weight cement to crushed Stone Aggregate.	
Very low	0.4	1:4.8	1:5.3	1:4.5	1:5.4
Slump	0.5	1:7.2	1:7.7	1:6.6	1:7.4
0.25 mm	0.6	1:9.4	1:10.0	1:7.8	1:9.6
	0.7	1:10.0	1:12.0	1:8.7	1:10.0
Low	0.4	1:3.9	1:4.5	1:3.5	1:4.0
Slump	0.5	1:5.5	1:6.7	1:5.0	1:5.5
25.60 mm	0.6	1:6.8	1:7.4	1:6.3	1:7.0
	0.7	1:6.0	1:8.5	1:7.4	1:8.0
Medium Slump	0.4	1:3.5	1:3.8	1:3.1	1:3.6
	0.5	1:4.8	1:5.7	1:4.2	1:5.0
50.100 mm	0.6	1:6.0	1:7.3	1:5.2	1:6.2
High	0.4	1:3.2	1:3.5	1:2.9	1:3.3
Slump	0.5	1:4.4	1:5.2	1:3.9	1:4.6
100 – 175 mm	0.6	1:5.4	1:6.4	1:4.7	1:5.7
	0.7	1:6.2	1:7.4	1:5.5	1:6.5

NOTE: (1) Notwithstanding anything mentioned above. The Cement/total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Engineer-in-charge.

NOTE: (2) It should be noted that such high aggregate cement ratios will be required for concretes of every low slump and high water cement ratios which may be required to be used in mass concrete work only.

NOTE: (3) The above figures are for guidance only. The actual cement aggregate ratios are to be worked out from the specific gravities of Coarse Aggregates and sand being used and from trial mixes.

54.6 – TABLE – III:

MINIMUM CEMENT CONTENT SPECIFIED FOR DIFFERENT GRADES OF CONCRETE. (Also refer table 3 & 5 of IS 456 /2000

<u>Grade of concrete</u>	<u>Minimum Cement Content/Cu.M Of finished Concrete.</u>
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M – 15 (Moderate Exposure)	300 kg
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M – 20 (Severe Exposure)	320 kg.
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The minimum cement contents mentioned in Table – III are for average conditions. The Engineer-in-charge shall have the right to revise the minimum cement content.

54.7. In this connection the contractor shall abide by the following conditions.

54.7.1. The contractor shall design the mixes for 10% (Ten percent) higher strength over and above those specified in Table – I under Clause 54.4 for the various grades of concrete and different slump requirement.

54.7.2. Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of W/c. ratio Vs crushing strengths at various ages will be plotted.

54.7.3. All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS:456.

54.7.4. The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

54.7.5. At least 4 trial batches are to be made and 7 test cubes taken for each batch noting the slump of each mix. The cubes shall then be properly cured and two cubes for each mix shall be tested in a testing laboratory approved by the Engineer-in-charge at 7 days and others at 28 days for

obtaining the compressive strength. The test reports shall be submitted to the Engineer-in-charge. The cost of the mix design and testing shall be borne by the contractor. All tests shall be done in the presence of Engineer-in-charge.

54.7.6. Concrete tests specimens shall be made, cured and tested in conformation with IS:516 (latest edition). These tests shall be conducted at approved laboratory. The modules and materials for cubes shall be supplied by the contractor who shall also arrange to transport the cubes/cylinders to laboratory at his cost.

54.7.7. The reports for each tentative concrete mix submitted for review the include the following information.

- a) Slump on which the design is based.
- b) Total litres of water per cubic meter.
- c) Water cement ratio
- d) Ratio of fine to total aggregates
- e) Weight (surface dry) of each aggregate per Cubic meter.
- f) Quantity of each admixtures.,
- g) Air content if any
- h) Compressive strength based on 7 days and 28 days compression tests.
- i) Time of initial set
- j) Time of final set
- k) Weight of cement used in the mix.

54.7.8. On the basis of the above reports, a proportion of mix by weight and water cement ratio shall be approved by the Engineer-in-charge which will be expected to give the required strength, consistency and workability and the proportion so decided for different grades of concrete shall be adhered to during all concreting operations. If however, at any time, the Engineer-in-charge feels that the quality of material being used has changed from those used for preliminary mix design, the contractor shall have to run similar trial mixes to ascertain the mix proportions and water cement ratio for obtaining the desired strength and consistency.

54.7.9. The design mix particulars shall indicate by means of graphs and curves etc., the extent of variation in the grading of aggregate which can be allowed.

54.7.10. In designing the mix proportions of concrete the quantity of both cement and aggregate shall be determined by weight. The Engineer-in-charge may allow the quantity of aggregates to be determined by equivalent volume basis after the relation-ship between the weight and volume is well established by trial and the same shall be verified frequently. Water shall be either measured by volume in calibrated

tanks or weighed. All measuring equipments shall be maintained in a clean and serviceable condition and their accuracy checked periodically.

- 54.7.11. To keep the water cement ratio to the designed value, allowance shall be made for the moisture contents in both fine and coarse aggregates and determination of the same shall be made as frequently as directed by the Engineer-in-charge. The determination of moisture contents shall be according to IS:2386 (Part – III).
- 54.7.12. It will be within the competency of the Engineer-in-charge to reduce the number of the batches and the number of test specimens mentioned above. Further the Engineer-in-charge can also allow adoption of the mixes already tried and found satisfactory, with similar materials, for other jobs at the same site without any fresh design of mix.

55.0. STRENGTH REQUIREMENTS:

- 55.1. The mix proportions for all grades of concrete shall be designed to produce the grade of concrete having the required workability and a characteristic strength not less than the value given in Table-I vide clause 54.4.

NOTE: The strength concrete given above is the 28 days characteristic compressive strength of 15 cm cubes.

- 55.2. The type of cement used for the preparation of concrete shall conform to the specifications given in relevant Indian Standard Code. The acceptance of strength of concrete shall be as per "Acceptance Criteria" IS:456, subject to stipulations and/or modifications stated elsewhere in the specification.
- 55.3. Concrete work found unsuitable for acceptance shall have to be dismantled and replaced to the satisfaction of the Engineer-in-charge by the contractor free of cost to the owner. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc., wasted in the dismantled portions shall be made. In the course or dismantling, if any damage is done to the embedded items of adjacent structures, the same shall also be made good free of charge by the contractor to the satisfaction of the Engineer-in-charge.
- 55.4. In exceptional circumstances the Engineer-in-charge may accept a concrete of lower strength than specified which is otherwise unacceptable according to the "Acceptance Criteria" of IS : 456 provided the strength is never less than 80% of that specified shall always be rejected. Payments for concrete of lower strength than specified, but accepted by the Engineer-in-charge shall always be made at a reduced rate prorated to the strength obtained.

55.5. With permission of the Engineer-in-charge, for any of the above mentioned grades of concrete, if the water quantity has to be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment for the additional cement will be made.

55.6. Durability Requirement:

55.6.1. Tables 4 & 5 of IS:456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be a important consideration.

55.6.2. Whenever the water cement ratio dictated by durability consideration is lower than that required from strength criteria, the former shall be adopted.

55.6.3. However, water cement ratio, from the point of view of durability as well as from strength consideration, should meet the requirements given in Table No.II.

56.0. WORKABILITY:

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the comers of formwork and around the reinforcement and embedment and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE – IV:

LIMITS OF CONSISTENCY:

Degree of workability	Slump in mm with standard cone as per IS:1199.		Use for which concrete is suitable.
Very low	0	25	Large mass concrete structure with heavy compaction equipments, roads and like.
Low	25	50	Uncontested wide and shallow RCC structures.
Medium	50	100	Deep but wide CC with congestion

			or reinforcements and inserts.
High	100	150	Very narrow and deep RCC structures with congestion due to reinforcement and inserts.

NOTE: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS:1199 and clause 6 of IS:456 shall be carried out.

57.0. BATCHING:

- 57.1. In proportioning concrete, the quantity of both cement and aggregate should be determined by weight, where the weight of cement is determined on the basis of weight of cement per bag, a responsible number of bags should be weighed periodically to check the net weight, where the cement is weighed on the SITE and not in bags it should be weighed separately from the aggregates. Water should be either measured by volume in calibrated tanks or weighed. Any solid admixture that may be added, may be measured by weight, liquid and paste admixture by volume or weight. Batching Plant where used should conform to IS:4925 – 1968. all measuring equipment should be maintained in a clean serviceable condition, and their accuracy periodically checked.
- 57.2. Except where it can be shown to the satisfaction of the Engineer-in-charge that supply on properly graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate should be controlled by obtaining the coarse aggregate in different size and blending them in the right proportion when required different sizes being socked in separate stock files, the grading of coarse and fine aggregate should be checked frequently for a given job being determined by the Engineer/in/charge to ensure that the specified grading is maintained,
- 57.3. Change from weight batching to volume batching maybe done only after obtaining the specific permission of Engineer-in-charge in writing.
- 57.4. The amount of the added water shall be adjusted to compensate for any observed variation in the moisture contents. For the determination of moisture content in the aggregates , IS:2386 (Part-I) may be referred to. To allow for the variation in their moisture content suitable adjustments in the weights of aggregate shall be made, In the absence of exact data only

in the case of Nominal Mixes the amount of surface water may be estimated from the values given in Table/C,

TABLE – C:

SURFACE WATER CARRIED BY AGGREGATE:

Aggregate	Approximate Qty. of surface water	
	Percent by Mass	Litre M3
Very wet sand	7.5	120
Moderately wet sand	5.0	80
Moist sand	2.5	40
Moist gravel or crushed rock	1.25 – 2.5	20 - 40

57.5. No substitutions in materials used on the work '0' alterations in the established proportions, except as permitted in clauses 7.76.3 & 7.7.6.4 shall be made without additional tests to show that the quality and strength of concrete are satisfactory.

57.6. Workmanship:

General:

All workmanship shall be according to the latest and best possible standards.

Before starting a pour the contractor shall obtain the approval of the Engineer-in-charge in a "Pour Card" maintained for this purpose. He shall obtain complete instructions about the material and proportion to be used, slump, workability, quantity of water per unit of cement, number of test cubes to be taken type of finishing to be done, any admixture to be added, any limitation on size of pour and stopping premature pours.

58.0. MIXING OF CONCRETE:

All control/design mix concrete shall be mixed at a single central batching plant situated within the area allocation for the contractor's particular use as shown on the drawings. The plant shall have mechanically operated mixer of an approved size and type capable of ensuring a uniform distribution of the

materials throughout the mass. The entire batch shall be discharged before recharging.

The proportions of the fine and coarse aggregate, cement and water shall be as determined by the mix design or according to fixed proportions in case of nominal mix concrete and shall always be approved by the Engineer-in-charge. The quantities of the cement, fine and coarse aggregate shall be determined by weight, the water shall be measured accurately after giving proper allowance for surface water present in the aggregate for which regular check shall be made by the contractor.

The water shall not be added to the mix until all the cement and aggregates constituting the batch are already in the drum and dry mix for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass done for less than two (2) minutes and at least forty (40) revolutions after all the materials and water are in the drum. When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer-in-charge. Mixers shall not be loaded above their rated capacity as it prevents thorough mixing. If there is segregation after unloading from the mixer the concrete should be remixed.

Before beginning a run of concrete all partially set or hardened concrete and foreign material shall be removed from the inner surfaces of mixing and conveying equipment. The first batch, of concrete, through a cleaned mixer, for use in the works, shall contain 10% additional cement at no extra cost to the owner, to allow for loss in the drum.

59.0. CONVEYING CONCRETE:

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in spite of all precautions, segregation does occur during transport, the concrete shall be properly remixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers which will reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from set concrete. Concrete shall not be delivered by spout or through nor dumped into carriers with a free fall from the mixer of more than 6m.

No concrete shall be placed except in the presence of the Engineer-in-charge or his authorized representative. Concrete which is not placed in accordance with the specifications or which is of inferior quality as determined by

the Engineer-in-charge, shall be removed and replaced by the contractor, the entire cost of which shall be borne by the contractor.

Before, any concrete is placed, the entire placing programme consisting of equipment, layout, proposed procedure and methods shall be submitted in writing to the Engineer-in-charge for approval and no concrete shall be placed until his approval has been received.

Concrete shall be conveyed to the point of final deposit by methods which will prevent the separation or loss of the ingredients. Concrete shall be deposited in its final position without moving it laterally in the forms for a distance in excess of 1.5 metres.

60.0. PLACING AND COMPACTING CONCRETE:

60.1. Where specifically covered, the relevant IS code will be following for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in the relevant IS code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces.

- a. Earth foundation.
- b. Rock foundation.
- c. Formwork.
- d. Construction joint in concrete or masonry.

60.2. The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc., are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be rammed and consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.

60.3. Formwork, reinforcement, preparation of surface, embedment, joint scales etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

60.4. Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be detached completely,

special procedure and precaution, as directed by the Engineer will have to be adopted.

60.5. Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement. Before concrete is placed, forms, reinforcement, anchor bolts and embedments shall be rigidly secured in proper position. Concrete shall be deposited in its final position without segregation, re-handling or following loss of liquid from concrete. The interval between adding the water to the dry materials in the mixer and the completion of the final placing inclusive of compaction of the concrete shall be well within the initial setting time for the particular cement in use or as directed by the Engineer-in-charge.

60.6. A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed and cement slurry will be spread thoroughly on the rock foundation or construction joint just prior to placement of concrete. The cost of application of such cement slurry and mortar will be deemed to be included in the unit rate of concrete.

60.7. To ensure bond and water tightness between old concrete surface and the concrete to be placed, the surface should be cleaned and roughened by "initial green out" by wire brushing or chipping. The initial green cutting may be done after 6 hours of placing concrete in-order to facilitate the work. Before plastering, the surface shall be thoroughly hacked. The bonding of old and new concrete should be done by applying the cement slur after thoroughly watering the old concrete surface and removing all free particles.

60.8. The placing of concrete shall be a continuous operation with no, interruption in excess of 30 minutes between the placing of continuous portions of concrete.

60.9. After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. To secure maximum density and eliminate formation of air pockets, the concrete shall be thoroughly vibrated and worked around all reinforcement, embedded facilities and into corners or forms during and immediately after placing. Unless other methods are authorized by the Engineer-in-charge, mechanical vibrators conforming to IS:2505, IS:2506, IS:2514 and IS : 4656 (all latest edition) shall be used for this purpose, the type and operation of which is subject to the approval of the engineer-in-charge. The extent of vibration shall be through the entire depth and width of each new layer. Duration of vibration shall be sufficient to accomplish thorough compaction and complete embedment reinforcement. Due to vibration, the tendency for large aggregate to gravitate to lower elevations shall not relieve the contractor from the responsibility of obtaining a uniform density throughout the mass. Excess cement paste thus formed at the top of each layer shall be removed before the succeeding layer is deposited. Vibrations shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by

experienced workmen and the work carried out as per relevant IS Code of Practice. In thin members with heavy congestion of reinforcement or other embodiments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS : 4656. For slabs and other similar situations, the contractor will additionally employ screed vibrator as per IS : 2506, hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete. Contractor shall provide proper equipment or methods for compaction of concrete or covers or other similar areas where conventional methods would not be adequate.

60.10. Immersion type vibration shall be provided at the rate of at least one '65 mm' until per cu.m. per hour together with at least one stand by vibrator of the appropriate size. Vibrators shall be inserted in the concrete at a sufficient number of places so that their fields of influence overlap and shall not be used to work the concrete along with forms or screeds. Vibrators shall be withdrawn causing segregation, avoided. Where electrically operated vibrators are used, diesel or petrol driven stand by vibrators shall be available for carrying on uninterrupted vibration in case of a power failure.

60.11. The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

60.12. Slabs, beams and similar members shall be poured in one operation, unless otherwise, instructed by the Engineer. In special circumstances with the approval of the Engineer-in-charge these can be poured in horizontal layers not exceeding fifty (50) cm. depth. When poured in layers, it must be ensured that the under layer, is not already hardened. Bleeding of under layer if any, shall be effectively removed. Molding, throwing, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided, and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as , directed by the Engineer. Any deviation there from shall be set right by the contractor at his own expense as instructed by the Engineer.

- 60.13. Concrete shall be deposited in a manner to prevent displacing facilities or reinforcement above the level of the fresh concrete, and the formation of seams or planers of weakness within the sections. Each layer shall be deposited as close to its final position at practicable in order to prevent segregation.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same at the contractor's expense.

- 60.14. The Engineer shall decide upon the time interval between two placement of concrete of different ages coming in contract with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

- 60.15. Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

- 60.16. Whenever vibration has to be applied externally the design of formwork and the disposition of vibrators shall received special consideration to ensure efficient compaction and to avoid surface blemishes. After initial set of concrete the forms shall not be jarred and no strain or vibration equipment shall be placed on the ends of projecting reinforcement.

- 60.17. Concrete shall not ordinarily be placed under water. In unavoidable cases, such concreting shall be done only with the specific approval of procedure and application by the Engineer-in-charge. The concrete shall contain at least 10 percent more cement than that required for the same mix placed in the dry, the quality of extra cement varying with condition of placing. The relevant of IS : 456 (latest edition) should be adhered to.

- 61.0. Retarding of concrete or mortar which has partially hardened shall not be permitted.

It is imperative that all excavations prepared for concrete construction be maintained free of water until such concrete work is completed. The contractor shall make provisions and furnish equipment as required for such dewatering, subject to approval by the Engineer-in-charge. Water used for flushing concrete placing, equipment shall be discharged clear of the concrete and forms.

Contractor shall keep an accurate record of the date on which the concrete is cast for each part of work and date on which the forms are removed.

62.0. COLD WEATEHR CONCRETING:

When conditions are such that the ambient temperature may be expected to be 45. deg. C or below during the placing and curing period, the work shall conform to the requirement of Clause 13 of IS:456 and IS:7861.

63.0. HOT WEATHER CONCRETING:

When depositing concrete in very hot weather, the contractor shall take all precautions as per IS:7861 and stagger the work in the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38 deg. C while placing. Positive temperature control by pre-cooling post cooling or any other method shall be carried out as per ISS/other specification at no extra cost to the purchaser.

64.0. CONSTRUCTION JOINTS:

64.1. The locations and details of construction joints must be got approved from the Engineer-in-charge before concrete is poured. Concreting shall be carried continuously upto construction joints.

At least two hours must lapse after depositing concrete in the column or walls before depositing in beams, girders or slabs supported thereon. Beams, girders, brackets and haunches shall be considered as part of the floor system and shall be placed monolithically therewith.

64.2. Construction joints in foundations of equipment shall not be provided without specific concurrence of the Engineer-in-charge.

64.3. It is always desirable to complete any concrete structure by continuous pouring in one operation. However due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined sages. These joints will be formed in a manner specified in the drawings/instruction. Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedment and fixtures that may be shown of desired by the Engineer-in-charge keep and/or dowel bags shall be provided at the construction joints. For water retaining structures and leak proof buildings suitable and approved water stops may be installed at the construction joints as per clause 1.2.4 of IS:456.

64.4. Where the location of the joints are not specified, it will be in accordance with the following:

In a column, the joint shall be formed 75 mm below the lowest soft of the beam framing into it.

Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and at the one third of the span.

A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.

Feather-edges in concrete shall be avoided while forming a joint.

A construction joint should preferably be placed in a low stress zone and at right angles to the direction of the principal stress.

In case the contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean, thoroughly wetted and covered with a 1.5 mm layer of mortar composed of cement and sand in the ratio of 1.1. this 1.5 mm layer of mortal shall be fresh mixed and placed immediately before the placing of the concrete. The new concrete shall be worked against the prepared surface before the slurry sets. Special care shall be taken to see that the first layer of concrete placed after a construction joint is thoroughly rammed against the existing layer. Old joints during pour shall be treated with 1.1 freshly made cements sand slurry only after removing all loose materials.

Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of particles of aggregate. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 1.50 mm in thickness and shall be well rammed against old work, particular attention paid to concrete and close spots.

65.0 EXPANSION AND SAPARATION JOINTS:

- 65.1. Permanent expansion joints instructions shall be formed in the position and to the shapes shown in the drawings.
- 65.2. Location of joints shall strictly be as shown on drawings or as instructed by the Engineer-in-charge. Expansion joints shall be as shown on drawings

or specified in the schedule of items. Expansion joints filter boards conforming to IS:1858 (latest) or equivalent and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer-in-charge.

- 65.3. Separation joints shall be with standard water proof paper or with a alkathene sheets about 1 mm in thickness. Lap length and sealing of laps shall be to the satisfaction of the Engineer-in-charge.
- 65.4. The unit rate of concrete work shall include the cost of preparation of joints as mentioned above and no extra payment shall be admissible on this account.

66.0. INSERTS:

- 66.1. All anchors, anchor bolts, inserts, pipe, conduits, sleeves, floor angles frames, noising, bolts etc., and any other items that are required to be cast into the concrete shall be placed in correct position before pouring. Extra care shall be taken during pouring operation to maintain their locations. Blackouts and openings shall be kept as indicated in the drawings. All anchor bolts shall be embedded in concrete to a minimum depth of 45 mm.
- 66.2. Unless installed in pipe sleeves, anchor bolts shall be provided with sufficient threads to permit a nut not be installed on the concrete side of the form or template. A second unit shall be installed on the other side of the form or template and the two nuts shall be adjusted so that the bolt will be held rigidly in proper position.
- 66.3. Inserts shall not be welded to reinforcement.
- 66.4. Inserts shall be clean when they are installed. After concrete placement, surface not in contact with concrete shall be cleaned of all concrete spatter and other foreign substances.

67.0. REPAIRS AND FINISHES OF CONCRETE:

- 67.1. Adequate and sound concrete surfaces, whether formed or uniformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing and consolidation by experienced workmen.
- 67.2. All concrete surface either cast-in-site or pre-cast shall have even, clean finish, free from honey combs, air bubbles, fins or other blemishes.
- 67.3. Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will

not be accepted and will have to be dismantled, removed and replaced by sound concrete at the contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the contractor is able to repair it by approved methods like micro concrete at no extra cost to the purchaser. All concrete work shall be inspected by the contractor immediately after the forms are removed and he will promptly report concurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations.

- a) Sack, rubbing with mortar and storing with carbora dam stone.
- b) Cutting away the defective concrete to the required depth and shape.
- c) Cleaning of reinforcement and embodiment's.
- d) Roughening by sand blasting or chipping.
- e) Installing additional reinforcement/welded mesh fabric.
- f) Dry packing with stiff mortar.
- g) Plastering, suiting, shotcreting etc.,
- h) Placing and compacting concrete in the void left by cutting out defective concrete.
- i) Grouting with a cement sand slurry of 1:1 mix.

67.4. The requirement of finishes of formed surfaces are given separately under clause 8.6 of this specification. The contractor is to include in his quoted rate for concrete, the provision of normal finishes in uniformed surfaces which can be achieved by screeding, floating, troweling etc., as and where required by the Engineer without any extra cost to the purchaser. A few typical and common cases of treatment of concrete surface are cited below.

67.5. Except where a special finish is called for all exposed concrete shall be finished as follows:

67.6. All fins and other projections shall be neatly chipped, rubbed down and made smooth, form of shall be entirely removed by stiff fibre brushes. The use of acid shall not be permitted. All exposed corners shall be slightly rounded or chamfered. Air holes, cavities and similar imperfections shall be first saturated with water and filled with a mortar mixture of composition as that used in the concrete. After initial set of mortar the surface shall be rubbed down with burlap. A succor coat shall be allowed to be applied to the surface.

67.7. Floor

Whenever a non-integral floor finish is indicated, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing

all laitance. No over-trowelling, to obtain a very smooth surface, shall be done so it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked without any extra cost to the purchaser to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

67.8. To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

67.9. Beams, Columns and walls:

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

Concrete surfaces to be subsequently plastered or where brickwork shall be built against it shall be adequately hacked as soon as the form is stripped off so that proper bond can develop.

68.0. CURING OF CONCRETE:

68.1. Curing shall be as per this specification and IS : 456. Unless otherwise specified all concrete shall be moist cured by keeping all exposed surfaces, edges and corners continuously moist for at least twenty one days after being placed, by spraying ponding or covering with waterproof paper or moisture retaining fabric.

68.2. Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected against conformation from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be

protected from contact with such ground on with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent flotation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, expensive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc., that may impair the strength and durability of the concrete.

- 68.3. As soon as the concrete has hardened sufficiently, it shall be covered either with sand, Hessian, canvas burlap or similar materials which will hold moisture for long period and prevent loss of moisture from concrete.
- 68.4. Curing of concrete shall start after 8 hours of placement and in hot weather within 4 hours of placement of exposed faces. During the first 24 hours, the concrete shall be cured by use, of wet burlap 'O' such other means to cover the concrete surfaces. In very hot weather precaution shall be taken to see that the temperature of wet concrete does not exceed 38 deg. C while placing.
- 68.5. Concrete slabs and floors shall be cured by flooding with water of minimum 25 mm depth for the period mentioned above. Approved curing compounds may be used in lieu of moist curing with the permission the Engineer-in-charge. Such compounds applied to all exposed surfaces of the concrete as soon as possible after the concrete has set.

The contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case any lapse on the part of the contractor is noticed by the engineer, he will inform the contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the contractor, or pay for the part where adequate curing was noticed at a reduced rate, entirely at the discretion of the Engineer.

- 68.6. Wash Water:

Wash water shall be removed in a manner to prevent running down and staining of concrete surfaces which will be exposed at the completion of the work. Should unsightly wash water streak develop on the exposed surfaces, they shall be removed to a Engineer-in-charge.

69.0. TESTING AND ACCEPTANCE CRITERIA:

69.1. General: The contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards at his own cost, in a laboratory approved by the Engineer-in-charge and submission of the test.

69.2. Testing of concrete:

a) Normally, only compression tests shall be performed but the Engineer-in-charge require other test to be performed accordance with IS:516 (latest edition).

b) For each grade of concrete as follows:

Quantity of concrete in the work in cu.m.	Number of samples.
1. 2. 3. 4. 51 & above	4 plus one additional for each additional 50 cu.m. part thereof.

However at least one sample shall be taken from each shift.

At least specimens per sample shall be taken and 3 (three) of these shall be tested at 7 (seven) days and remaining at 28 days. Minimum compressive strength of 15 cm cubes of different grades of concrete at 7 days shall be as per table 5 of IS:456 – 1978.

c) To control the consistency of the concrete from every mixing plant, slump tests and/compaction factor tests in accordance with IS:1199 shall be carried out by the contractor every two hours or as directed by the Engineer-in-charge. Slumps corresponding to the test specimens shall be recorded for reference. The Engineer-in-charge, at his discretion, may waive the above tests for small and unimportant concreting.

69.3. Acceptance criteria for concrete:

a) The acceptance criteria of concrete shall be in accordance with IS:456 (latest edition). However, in exceptional circumstances, the Engineer-in-charge may, at his discretion, accept a concrete of lower strength than specified and which is otherwise unacceptable according to IS:456 (latest edition).

- b) Payment for concrete which is normally unacceptable as per the criteria laid down in IS:456 but has been accepted by the Engineer-in-charge shall be made at a reduced prorata to the strength obtained.
- c) Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the contractor. No payment shall be done for the dismantled concrete the relevant form work and reinforcement, embedded fixtures etc., wasted in the dismantle. If any damage, is done to the embedded items or adjacent structures, the same shall be made good, free of charge by contractor, to the satisfaction of Engineer-in-charge.
- d) The dimension of concrete as cast when compared with those on the drawing shall be within the tolerances given below, steps in surface alignment shall not exceed 2 mm.

No reduction will be permitted in the cover to reinforcement because of a specified negative tolerance in a concrete section.

Structural Element Detail	Permissible deviation in mm	
Faces of concrete in foundations and structural members against which backfill is placed.	+25	-5
Exposed concrete in foundations	+ 10	- 5
Top surfaces of slabs and of concrete to received grouted plant or structural steel work.	+ 10	- 5
Alignment of beams, columns, walls, slabs and similar items.	+5	-5
Cross sectional dimensions of beams, columns, walls, slabs and similar items.	+5	-5
Level and alignment of holding down bolts.	+5	-5
Level of holding down bolt assemblies.	+10	-5
Alignment of holding down bolt assemblies.	+5	-5
Centres of pockets or holes with greatest lateral dimension not exceeding 150 mm	+5	-5
Centres of pockets or holes with greatest lateral dimension exceeding 150 mm	+10	-5
Departure from alignment in roads and paved areas.	+15	-5
Top surfaces of roads and paved areas	+5	+5
Pump	1 in 100 of height	

70.0. LOAD TEST CONCRETE:

The load test on concrete, if desired by the Engineer-in-charge shall be carried as soon as possible after the expiry of 28 days from the time of placing of concrete as per the clause 16.5 to clause 16.6 of IS:456 – 1978. The entire

cost of the load testing shall be born by the contractor and if, any portion of the structure found unacceptable under the relevant clause IS:456 the same shall be dismantled and replaced by a new structure as per specification at no extra cost to the owner. If during dismantling any of the adjacent structure gets damaged, the same shall be made good free of charge by the contractor, to the satisfaction of the Engineer-in-charge.

71.0. METHOD OF MEASUREMENT:

71.1. Actual volume of work as executed as per drawing issued, whichever is less, shall be measured in cubic metre correct upto second place of decimal deductions for openings, conduits, pipes, ducts, pockets, chases etc., shall be made provided they are larger than 0.1 sq.m (for each opening upto and less than 0.1 sq.m in area the formwork shall not be paid for separately).

No deduction shall be made for embedded fixtures including reinforcements, sleeves, anchor bolts and similar items.

71.2. Measurement & Payment:

Payment for plain and reinforced cement concrete in site shall be made on cubic meter basis of the actual finished work done or as per approved construction drawings, correct upto second place of decimals, whichever is less and shall be inclusive of all labour, materials, curing cost of leaving pockets, and providing one coat of cement wash. Opening in walls and slab, necessary of all sizes. Providing benching making channels in manhole bottom etc., the rate shall also include supply and application of cement slurry prior to concreting of construction joints. The ; rates shall be deemed to include complete cost of taking and testing concrete cubes and carrying out other tests as per specifications and as directed by Engineer-in-charge.

Payment of concrete covered under this item is inclusive of organizing continuous pours as indicated on the drawings and no extra shall be payable on this account.

The rate shall however, be exclusive of steel work in reinforcement and metal inserts pipe sleeves. The rate is inclusive of all shuttering, centering and form work unless otherwise specified. However, the preparation of expansion/construction/separation joints, whichever required shall not be paid separately.

Where the strength of concrete mix (normal) or controlled as indicated by tests, lies in between the strength of any two grades given in clause 8.5.0 and it is accepted by the owner, such concrete shall be classified as a grade

;belonging to the lower of the two grades between which it lies. In case the cube strengths show higher results than those specified for the particular grade of the concrete, it shall not be placed in the higher grade nor shall the contractor be entitled for any extra payment on such account. The concrete giving lower strength than specified may be accepted at reduced rates after satisfying safety of the structure by checking it with devices such as the discretion of the owner. The rejected concrete shall be dismantled at no extra cost to the owner nor any payment will be made for the concrete so rejected and the shuttering and reinforcement used for the same.

72.0. DEDUCTIONS FOR POCKETS SHALL BE AS SPECIFIED IN RELEVANT INDIAN STANDARDS:

72.1. Water proofing compound like "CICO" Grade-I or "PUDDLO" of approved equivalent used for concrete or mortar shall be paid separately on the basis of weight of such compound consumed. The rate of quoted for supply and mixing water proofing compound should include cost of all such materials including taxes etc., bringing to site storing and addition to the concrete or mortar so specified by the manufacturer.

72.2. IS Codes : Important relevant IS for this section:

IS:456	: Code of practice for plain and reinforced concrete.
IS:1190	: Methods of sampling and analysis of concrete.
IS:1838	: Preformed filters for expansion joints in concrete non-extruding and resilient type (bitumen impregnated filter).
IS:2366	: Part-III : Specific gravity, density, voids, absorption and buckling.
IS:2505	: General requirements for concrete vibrators, immersion type.
IS:2506	: Screed board concrete vibrators.
IS:2514	: concrete vibrating tables.
IS:3025	: Methods of sampling and test (Physical and chemical).
IS:3370	: Code of practice for concrete structure for the storage of liquids.
IS:3350	: Methods of tests for routine control for water used in Industry.
IS:4656	: Form vibrators for concrete.

73.0. Sampling & Testing in field:

73.1. Grading Test: Grading tests on coarse and fine aggregates shall be carried out at intervals specified by the Engineer-in-charge.

73.2 : Slump Test on concrete: At least one slump test shall be made for every compressive strength test carried out. More frequent test shall be made if there is a distinct change in work conditions, or if required by the Engineer-in-charge.

73.3. Strength test of concrete: Samples of concrete shall be taken at the direction of the Engineer-in-charge in the field in accordance with IS:1199 "Methods" of sampling and analysis of concrete.

These shall be tested for strength and consistency at an approved Government Laboratory as specified by the engineer-in-charge in accordance with IS:516. The moulds and material for cubes and cylinders shall be supplied by the contractor who shall also arrange to transport the cubes/cylinders to laboratory at his cost. Actual cost of the testing shall be borne by the contractor.

73.4. the acceptance criteria for the compressive strength shall be as per IS:456. Only the slump, indicated for the approved design mix shall be adopted. However, larger slumps than those indicated in approved design mix, of concrete of a specified grade (strength) may be necessary to get a workable consistency for concrete in case of beams, columns and other heavily reinforced members. No extra payment shall be made for extra cement that may have to be added in such cases to get the concrete of the same specified grade (strength) with larger slumps. The decision of Engineer-in-charge regarding the degree of consistency of the amount of slump shall be final.

Samples shall be cured under laboratory conditions except when in the opinion of the Engineer-in-charge extreme weather condition may prevail at which time the Engineer-in-charge may required curing under job conditions.

If the test strength of the laboratory controller cubes/cylinders for any portion of the concrete work falls below the compressive strength specified, the Engineer-in-charge shall have the right to order a change in the proportion of the water content for the remaining portion of the structure.

73.5. If the test strength of the job cured cubes/cylinders falls below the specified strength, the Engineer-in-charge shall have the right to require provision for temperature and moisture control during curing as necessary to secure the required strength and may require retests in accordance with standard method of securing, preparing and testing specimens from hardened concrete for

compressive and flexural strength or order loads tests to be made on the portion of in the building so affected. All such tests shall be made at contractor's expenses.

73.6. When the cubes tested reveal a strength lower than those specified, the acceptance criteria for such concrete shall be decided as stipulated in IS:456 (latest edition). The Engineer-in-charge shall also reserve the right to reject whole or any part of the work. In case of acceptance of such works the standard deviations shall be worked out and examined by the Engineer-in-charge and if he is satisfied only then such work can be accepted at the reduced rate. The amount to be deducted shall be decided by the Engineer-in-charge

73.7. for the purposes of statistical analysis any cube result, which in the opinion of Engineer-in-charge is due to improper sampling, moulding or testing shall be discarded and a dummy result shall be substituted. The value of the cubes from the same grade of concrete tested immediately before and after the discarded and a dummy result shall be substituted. The value of the cubes from the same grade of concrete tested immediately before and after the discarded value.

73.8. The contractor shall prepare and submit to the Engineer-in-charge a sample form to be used during the batching and mixing of the concrete. The form shall provide for entries to be made which will indicate the quantity of each material placed in each mixer, the mixer identification number, the batch number, the duration of time the batch was mixed, and the name or initials of the person recording the information.

The contractor is responsible for recording the required information for each batch of concrete and for submitting the required number of copies of completed form to be Engineer-in-charge.

73.9. Strict quality control shall be exercised in all concreting works and the acceptance criteria of concrete shall be in accordance with IS:456 – 2000. the Engineer-in-charge shall have the right to reject whole or any part of the work done with concrete not meeting the strength requirements irrespective of the allowances as given in IS:456 – 2000. However in exceptional circumstances the Engineer-in-charge may at his discretion, accept a concrete of lower strength than specified and which is otherwise acceptable according to IS:456 – 2000.

73.10. Failure of the concrete to meet the early age strengths at 7 days shall be considered a failure of the concrete to meet the strength requirements and the Engineer-in-charge in such instances shall have the right to stop construction. The early age strength shall be the mean strength at the specified age minus 2 times standard deviation for the specified age.

73.11. Concrete work found unsuitable for acceptance shall be dismantled and replacement is to be done as per specification by the contractor. No payment for the dismantled concrete, the relevant form work and reinforcement embedded

fixtures etc., washer in the dismantled portion shall be made. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the contractor to the satisfaction of the Engineer-in-charge.

The dimension of concrete as cast when compared with those on the drawings shall be within the tolerances specified on IS code. No reduction will be permitted in the cover to reinforcement because of a specified negative tolerance in a concrete section.

Only the slump indicated in the approved design mix shall be adopted. However larger slumps than those specified grade (strength) may be necessary to get a workable constituency for concrete in case of beams, columns and other heavily reinforced members. No extra payment shall be made for extra cement that may have to be added in such cases to get the concrete of the same specified grade (strength) with larger slumps. The decision of Engineer-in-charge regarding the degree of constituency of the amount of slump shall be final.

74.0. FREQUENCY OF SAMPLING:

The minimum frequency of sampling of concrete for each grade shall be in accordance the following:

Quarterly of concrete in the work M3	Number of samples.
1.	
2.	
3.	
4. 51 and above	4 Plus one additional sample for each additional 50 m ³ or part thereof.

Test Specimens: Six test specimens shall be made from each sample for testing three at 7 days and after three at 28 days.

Test strength of sample: The test strength of the sample shall be the average of the strength of three specimens. The individual variation should not be more than + 15 percent of the average.

75.0. STANDARD DEVIATION:

Standard Deviation tested on Test Results:

- a) Number of test results: The total of test results required to constitute and acceptable record for calculation of standard deviation shall be not less

than 30. Attempts should be made to obtain the 30 test results, as early as possible, when a mix is used for the first time.

- b) Standard deviation to be brought to date: The calculation of the standard deviation shall be brought up to date after every change.
- c) Concrete of each grade shall be analysed separately to determine its standard deviations.

Assumed standard deviation: Where sufficient test results for a particular grade of concrete are not available, the value of standard deviation given in Table D may be assumed.

TABLE – D:

Grade of concrete	Assumed Standard Deviation N/sq.mm
M – 10	2.3
M – 15	3.5
M – 20	4.6.

However, when adequate past records for a similar grade exist and justify to the designer a value of standard deviation different from that shown in Table-D it shall be permissible to use that value.

76.0. TECHNICAL SPECIFICATION FOR R.C.C. RAIL TRACK:

76.1. Scope: This section covers the technical requirement for supplying, laying, fixing etc., of main rails and guide angles, base plates, bolts, angles etc., for laying the rail track of different gauges on R.C.C. bed (Ballast less rail track).

76.2. Materials: guide angles, base plates etc., required for fixing the rails on RCC bed shall be of mild steel conforming to IS:226 / IS:2026 (latest) and the bolts, nuts and clips etc., shall conform relevant Indian Railway Standard/IS codes.

Plain cement concrete shall be of M 10 grade conforming to IS:456 – 1978. for specification refer specifications under sub-head concrete.

Reinforcement cement concrete shall be of M 20 grade conforming to IS:456 – 1978 and reinforcement shall be of high strength deformed bars conforming to IS:1786 (latest). For specification of RCC works refer to specification under sub-head concrete 'Form work' and 'Reinforcement : Fabrication bending and placing'.

The grouting of the foundation/anchor bolts and base plates etc., shall be carried out either by using non-shrinkage cement or non-shrinkage admixture in the grout.

76.3. Sub-base: The sub-base for the RCC bed shall be prepared as per the Indian/Railway Standard for B gauge Lines.

Laying of Track:

The rails shall be laid true with gradient and slope and shall match with the levels shown on the approved drawings. The rails shall be laid and fixed in position on RCC bed as per approved drawings and in accordance with Indian Railways Specifications for Broad Gauge Lines. The top of RCC shall flush with top of rail.

The portion of rail track coming on transformer/react foundations shall be laid on the concrete pedestals with fixing bolts as shown on the approved drawing.

The intersection of rail tracks shall be designed to allow easy and free movement of the transformer from one track to the other. Intersection may be combined with anchor and jack points wherever possible.

The complete details of railway track to be laid shall be submitted by the contractor to the Engineer-in-charge/Owner's consultant for approval. No track shall be laid without the approval of the Engineer-in-charge.

76.4. Measurement:

The measurement for the above work shall be in running meters, excavation back filling, plain cement concrete, structural concrete form work and reinforcement shall be measured separately as per their respective sub-heads and paid for.

76.5. Roads and Drainage:

76.5.1. Scope: this specification covers all work required for the construction of road including box-cutting, edging, sub-base water bound wearing course etc., and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

77.0 GENERAL:

Work to be provided by the contractor.

- a) Furnish all labour, supervision services, materials, equipment, tools and plants, transportation etc., required for the work.

- b) Submit for approval detailed schemes of all operations required for executing the work e.g. material handling, placement, services, approaches.
- c) To carry out and submit to the Engineer the results of tests whenever required by the Engineer to assess the quality of work.

77.2. Work to be provided for by others.

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

Codes and Standards:

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant I.S. Specifications and codes of practice.

(i) Longitudinal Profile:

The levels of the sub grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross profile of the road shown on the drawings or as directed by the Engineer beyond tolerances mentioned below.

Sub grade +25 mm

Sub base + 20 mm

Base course + 15 mm

Wearing course + 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance for base course if the thickness of the former is thereby reduced by more than 6 mm.

(ii) Surface Regularity of Sub-grade and Pavement courses:

The surface regularly of completed sub-bases, base courses and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table-I.

The longitudinal profile shall be checked with a 3 meter long straight edge, at the middle of each traffic lane along a line, parallel to the center of the road. The transverse profile shall be checked with a set of three chamber boards at intervals of 10 meters.

TABLE - I

78.0. PERMITTED TOLERANCES OF SURFACE REGULARITY FOR PAVEMENT COURSES:

Sl. No.	Type of Construction	Longitudinal profile with 3 meter straight edge	Cross profile.	
		Maximum permissible undulation (mm)	Maximum number of undulations permitted in any 300 metres length exceeding. (mm)	Maximum permissible variation form specified profile under camber template (mm)
			18 12 10 6	

1.	Earthen sub-grade	25	30	---	---	---	15
2.	Granular sub base	15	---	30	---	---	12
3.	Water Bound macadam with oversize metal (40-90 mm size)	15	---	30	---	---	12
4.	Water Bound macadam with Normal size metal (20-50 mm, 40-63 mm size) Bituminous penetration macadam.	12	---	---	30	---	8
5.	Surface dressing two coat over WBM 12 (20-50 mm or 40-63 mm size metal) Bituminous penetration macadam or built up spray grout.	---	---	---	20	---	6
6.	Open graded premix carpet mix seal surfacing.	10	---	---	---	30	6
7.	Bituminous	---	---	---	---	---	6

1. (**) For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2. (***) There are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 per cent above these values in the column may be permitted at the discretion of the engineer. However this relaxation does not apply to the value of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

79.0. EXECUTION:

Shoulder Construction.

79.1. Description : this work shall consist of constructing shoulders on either side of the pavement.

In accordance with the requirement of this specification and in conformity with the lines, grades and cross-sections shown on the drawings so as directed by the Engineer.

79.2. Materials: Shoulder may be of selected earth or granular material conforming to the requirement of embankment construction or granular sub-base construction respectively.

79.3. Construction Operations: Except in the case of bituminous constructions, shoulders shall be constructed in advance of the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it.

After compaction, the inside edges of shoulders shall be trimmed vertical and included area cleaned of all spilled material before proceeding with the construction of the pavement layer.

In the case of bituminous courses, shouldering operations shall start only after the pavement course has been laid and compacted.

Regardless of the method of laying all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged onto the pavement surface shall be immediately removed, without damage to the pavement and the area so affected thoroughly cleaned.

During all stages of shoulder construction the required cross-fall shall be maintained drain off surface water.

80.0. Sub-base (Granular sub-base)

Description

This work shall consist of laying and compacting well-graded material on prepared sub-grade in accordance with the requirements of these specifications. The material shall be laid in one or more layers as shown on the drawings and according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

81.0. Materials:

The materials to be used for the work shall be natural sand morrum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, literate, kanker etc., or

combinations thereof depending upon the grading required. The mixed materials shall be free from organic or other deleterious constituents.

82.0. Materials:

Soling Stone;

It shall be clean, hard stone, free from decay and weathering. The size of the soling stone shall not be more than 225 mm and not less than 100 mm in any direction and its height shall be equal to the depth of soling stone as specified with a tolerance of 25 mm soling stone shall be obtained from the quarries approved by the Engineer-in-charge.

83.0. Stone Aggregate:

The stone aggregate shall be 40 mm (1-1/2 gauge) size and it defined as the % passing through the various sleeves as mentioned below:

Size of Aggregates:

Sieve No.	50 mm	40 mm	20 mm	12.50 mm
% passing	100	95-100	35-70	0-5

Murum:

The murum shall be composed of well graded coarse siliceous grains sharp and gritty touch and free from dirt and other deleterious matter. Murum shall conform to specification No.138 of APSS. The size of murum shall not be more than 10 mm.

Ref bajiri:

This shall be dark red in colour consisting of coarse grains, free from mica dust and other foreign matter.

Water used for works shall conform to IS : 456.

Binder paving:

- a) Road Paving: It shall be of the graded as specified to suit the type of construction and local conditions and shall generally conform to IS:215 – 1961 or as received.
- b) Bitumen of the specified grade and types shall be as described in the item. It shall be of two categories namely paving bitumen from Assam Petroleum and paving bitumen from other sources. Normally bitumen's with greater

penetration shall be used for surface painting and semi grouting work and bitumen with a lesser penetration for full grouting work and for conversion into out-backs by the addition of suitable oil or solvent. It shall conform to IS:73 (latest revision) and shall be heated to the temperature as shown below:

84.0. TABLE FOR PREMIX CORPETING:

Grade	Temperature to which it shall be Heated.
1. Out back bitumen's	:163 Deg C to 171 Deg. C
2. Paving asphalt 30/40 or 80/100 heated and at then mixed with solvent atmospheric temperature at the rate of 70 gm/kg of asphalt.	

85.0. EARTH WORK:

85.1. :Earth work in excavation:

Excavation shall include the removal of all materials to properly execute the work. Sides and bottom of excavation shall be cut sharp and the under cutting will not be permitted. The bottom of excavated nor shall be trimmed to the required levels and when carried out deeper by error shall be brought to the level by compacted back to the satisfaction of the Engineer-in-charge at the cost of the contractor. All specifications under clause "Excavations of the sub-section shall apply. Sides shall be excavated to the exact slope and terms as indicated in the approved drawings. All the useful materials and other finds such as sand, gravel, stone etc., and relics of antiquity, coins, fossils etc., met with during excavation shall remain the property of the department and shall be handed over to the Engineer-in-charge.

85.2. Earth in Embankment:

the embankment shall be formed of earth obtained either from borrow pits or from places as directed by the Engineer-in-charge and as provided and under clause filling with the following specification.

Before commencing any embankment the foot of the slope on each side shall be marked by pegs driven into ground at interval of 5 m or by a continuous digital to indicate the limits of the side slopes. Earth profiles shall then be set up for guidance of the workers at intervals along the embankment. These profiles shall show the total height of the embankment with due allowance for settlement.

No mud, slush or decayed matter of any kind shall be used Embankment shall be raised in regular layers not exceeding 200 mm thick. They shall be carried out to

the full width at the slopes, so that a additional earth is required for the slope, clods above 75 mm shall be broken up.

Each layer of earth shall be adequately watered to aid compaction. It shall then be rolled with roller of minimum $\frac{1}{2}$ tonne weight, not less than 5 times till it gets evenly and density consolidated. Where roller cannot work, the earth shall be consolidated with wooden or steel rammers of 7 to 10 kgms. Weight having a base of 20 cm square or 20 cm diameter. The labour for ramming shall be atleast one rammer to six daggers. Every third layer of earth and the top most layer shall be well consolidated with power roller of minimum 8 tonnes weight, rolled not less than 5 times, till the soil behaves as an elastic material and gets compressed only elastically under the load of roller.

Before placing the next layer, the surface of the under layer shall be moistened and scarified with pick axes or spades.

The top of the embankment shall be brought to the proposed levels and shall be neatly finished.

Cutting:

Where the formation level of the road is lower than the ground level, cutting shall be done upto formation level. Side slopes except in rock cutting shall be evenly and truly dressed.

85.3. Disposal of surplus earth.

Earth, not required for embankment shall be disposed of as directed by the Engineer-in-charge. The area where the surplus earth is disposed off shall be levelled and dressed.

85.4. Preparation of sub-grade

Treatment of Poor soil:

In sub-grade composed of clay, fine sand or other soils that may be forced up into the charge aggregate during rolling operation and insulation layer of granular materials of suitable thickness shall be provided for blanketing, the sub-grade.

If the formation level is above the natural ground level, the level is to brought to formation level by filling with gravel brought from borrow pits or with excavated earth near by the work as per the specification. When the excavated earth nearby the work is not sufficient gravel is to brought from borrow pits. The borrow pits shall be approved by the Executive Engineer. No stone, cobbles having maximum dimensions of more than 100 mm size shall be placed in the earth fill.

This work shall consist of laying and compacting Moorum (gravel) or excavated earth in accordance with the requirements of the specification. The material shall be laid in one of more layers as necessary to lines, grades and cross sections as shown in the drawings or as directed by the Executive Engineer.

The sub-grade shall be cleared of all vegetation and other extraneous matter. The Moorum or excavated earth shall be spread on the prepared sub-grade to the required lines, grades and cross sections as shown in the drawings or as directed by the Executive Engineer. It shall be consolidated under optimum moisture conditions with 2 to 3 tonne capacity roller. This work shall be executed as per specification No.1503 of APSS. The rate for each CUM for borrowing soils, transporting spreading watering compaction with 2 to 3 tonnes roller trimming the sides and ends of the embankment including stacking.

85.5. Consolidation of Sub-grade.

The sub-grade shall be consolidated with power road roller of 8 to 12 tonnes. The roller shall run over the sub-grade till the soil is evenly and densely consolidated and behaves as an elastic mass (roller shall pass minimum of 6 runs on the sub-grade).

85.6. Laying & consolidating soiling course:

85.7. Soiling Width:

The width of the soiling shall be 40 cm i.e. 15 cm more on either side than that of the wearing course. Its depth shall be 15 cm in cutting and 22.5 cm in filling and is made laid unless otherwise specified.

For 15 cm soiling actually 17.5 cm layer shall be laid and similarly for 22.5 cm soiling actually 26.0 cm layer shall be laid with suitable temperature.

85.8. Laying and Packing:

The stone in soiling shall be hand packed with greatest length across the road. These shall be laid closely in position on the sub-grade with its broadest side downwards and to make up the specified thickness of the base with single stones to correct camber and grade projections in stones which would result in excessive voids shall be knocked off with a hammer and or selected stone used to fit the shape of the stones already laid. The joints shall be staggered. All similar stones of suitable size wedged in with smaller stones of suitable size, well driven in, to enable tight packing and complete filling of interstices. Such filling shall be carried out simultaneously with the placing in position of soiling stone and shall not lag behind. All projecting corners above the surface level of the soiling shall be hopped off with hammers to bring them into home.

The surface shall be checked with templates of approved design (to be provided by the contractor) and high and low spots corrected by removing soiling and repacking.

85.9. Consolidation:

The soiling shall then be thoroughly consolidated with power roller of minimum 8 tonnes weight, starting at edges and working towards the center. The roller shall run over the same surface of rolling for atleast eight times till the soiling course is well consolidated. The surface shall be checked by templates, corrected after every rolling and finally consolidated. No more than 200 m of the road shall be under operation in any one Km at one and the same time unless otherwise directed by the Engineer-in-charge.

85.10. Cushion:

2.5 cm thick or as specified, layer of moorum or earth free from excess of clay as directed by the Engineer-in-charge, shall be laid on top of soiling course. This shall be rolled before the wearing course is laid.

85.1. Wearing course:

The wearing courses of stone aggregate earth 7.5 cm thick or as specified shall be provided. The first course shall be consolidated and thrown open to traffic atleast for a period of 2 to 6 weeks depending upon the intercity of traffic and the period available for completion of the work. The surface of the first course shall then be scarified, undulations filled up and the second course then laid according to profile and consolidated. The procedure of consolidation as given below should be repeated for both the course separately.

85.12. Shoulders:

Two parallel mud walls 20 x 15 cm shall be made along the outer edges of the wearing course. These shall be laid true and parallel having a clear distance between them equal to the width to be metalled.

85.13. Spreading & Packing stone aggregate:

Stone aggregate shall be raked off the stacks with the rakes so as to leave behind mud and dust. It shall be spread evenly over the prepared surface to the required depth, with a twisting motion to avoid segregation. Aggregate shall be carefully laid and packed, bigger size being placed at the bottom.

The thickness of the surface of new aggregate shall be checked with templates of approved design (to be provided by the contractor) which shall be set perfectly horizontal on the prepared surface at the intervals of not more than 15 m and surface rectified if necessary. The bottom member of the template shall be of a

depth equal to the unrolled thickness of the wearing course, where the aggregate is being spread. The aggregate when spread shall be correct to template.

NOTE: The camber of template shall not be flatter than 1 in 72.

85.14. Consolidation:

The stone aggregate shall be consolidated by dry rolling and wet rolling with power roller of 8 tonnes minimum weight. In case of straight reach of the road, the rolling shall be commenced at the edges and worked towards the center. In case of super elevated curve the rolling shall commence from the inside edge of the curve to the outside edge.

85.15. Dry rolling:

The stone aggregate shall first be rolled dry and when lightly sprinkled with just sufficient quantity of water to moist the earth cushioning below and to facilitate interlocking of aggregate rolling shall continue till the aggregate has become well consolidated and does not get displaced. During the process of rolling camber and grade of the aggregate surfaces shall be checked. All undulations shall be loosened by hand racking or racking tools, surplus materials removed from high spots and depressions filled with surplus and fresh material and the surface rolled again, small quantities of aggregate having been kept in stock for this purpose when all the surface defects are removed, dry rolling shall be stopped as otherwise the edges of the aggregate may get crushed which is not desirable.

85.16. Wet Rolling:

After the dry rolling has been completed as described above the road surface shall be watered copiously so as to keep the water level upto the top of the aggregate and rolling with power roller makes no visible impression on the surface and the interstices between the stone have been filled up by consolidation of aggregate and a piece of 25 mm size stone placed on surface gets crushed under the roller without being driven in.

85.17. Rolling with binding materials:

After wet rolling of the wearing surface course, the surface shall be tested with a 3 m straight, edge laid parallel to the center line of the road and any irregularity exceeding 12 mm shall be corrected by loosening the surface and recomposing the same after adding or removing materials as required. If further required by the Engineer-in-charge, the surface shall be checked with long string also.

Kankar moorum red bajiri in specified ratio shall then be spread evenly, over the surface to a 6 mm to 12 mm thickness copiously watered and rolled till the slurry, after filling all voids, shall form a wave before the wheels of the moving roller. Wet bajiri sticking to the wheel shall be removed simultaneously when the roller

is moving, by spades and sprinkling water on the wheels. The rolling shall be done on a minimum of four passes or till a hard smooth solid surface is obtained.

Finished surface shall give a uniform appearance and the road shall be closed to traffic till next day or lapse of 24 hours.

85.18: Edging:

Edging shall be done 275 mm wide and 110 mm deep or as specified with first class bricks.

85.19. Laying:

Trenches shall first be made along the edges of wearing coat of the road to receive bricks. Bricks shall be laid on edge with its length across the road shutting and running parallel to the road edge true to line and gradient.

85.20. Application of tack coat, laying of premix carpet 25 mm thick and laying of seal coat.

General:

This treatment consists of repairing and cleaning the surface, application of tack coat, laying of premix carpet 2.5 cm thick and laying of seal coat.

Preparation of surface for Repairs.

Pot holes, patches and ruts 25 mm deep shall be repaired by removal of all loose and defective material by cutting in rectangular patches and replacement with suitable material as described below:

Pot holes, patches and ruts 25 mm deep shall be repaired and brought to level with premix as described later and properly consolidated while those of depths more than 25 mm shall be repaired with the similar specifications as adopted originally.

85.21. Cleaning:

Prior to the application of tack coat, all dust, dirt, mud, animal dung, loose and foreign material etc., shall be removed to 30 cm on either side beyond the full width to be treated by means of wire brushes, small picks, brooms etc., the material so removed shall be disposed off as directed by the Engineer-in-charge.

85.22. Tack Coat;

The paving bitumen (out back bitumen) as mentioned in the specification shall be heated in a boiler to a temperature specified above and maintained at that temperature. This paving bitumen shall then be applied evenly to the already prepared dry surface by means of pressure sprayer at the rate of 0.75 kg/mts. Of the road surface.

The binder shall be applied longitudinally along the length of the road and never across it. The edges of tack coat shall be defined by wire or other cord lines stretched in position. This work shall not be done when the atmospheric temperature is less than 40 deg F 4-5 C.

85.23. Pre-mix carpet, preparation of mix and laying:

The stone aggregates of 10 mm nominal size as defined later shall be surface dry and contain not more than 2% moisture before use. It shall be screened of dust and measured in boxes and then loaded into the drum mixer according to the capacity of this drum. The aggregate shall be heated to facilitate mixing with the paving bitumen in cold weather, where so directed by the Engineer-in-charge. The stone aggregate will be used at the rate of 3 cubic metres per 100 sq. metres of the surface area.

The paving bitumen (cut back bitumen) will be heated to a temperature as mentioned earlier in a boiler. This heated bitumen shall be poured over the aggregate in the drum mixer at the rate of 64 kg per cubic metric of aggregate and mixing started and continued till aggregate is uniformly coated with bitumen.

This hot mix shall be spread on the road surface immediately after the application of tack coat to a thickness sufficient to achieve a thickness of 25 mm after consolidation.

85.24. Consolidation of pre-mix:

When the mix is sufficiently tacking and stiff and has not become hard or brittle, the carpet shall be compacted by a 6-8 ton roller until no impression is made thereby on the newly laid surfaces. The rolling shall progress gradually from each side towards the center. To prevent the premix from adhering to roller wheels the wheels shall be dampened by means of gunny bags soaked in water. Any high spot or depressions which become apparent shall be corrected by addition or removal of premix material. The finished surface shall be thoroughly compacted true to the correct levels and grades. Permissible tolerances will be as under:

Longitudinal section : + 6 mm for every 6 metres.

Cross Section : + 3 mm for the entire designed section.

85.25. Seal cost:

In this paving bitumen (out back bitumen) as specified earlier will be used at the rate of 1.5 kg/sq. metre of the surface area and stone aggregate 10 mm nominal size conforming to IS:383 shall be used at the rate of 1.1 cum per 100 sq. metre of the surface area.

The paving bitumen shall be heated as described earlier and applied on the surface and over this stone grit will be spread uniformly when the bitumen is still hot. The surface will be rolled as described earlier.

85.26. Opening to Traffic:

In the case of type A seal coat traffic shall not be permitted until the following day.

86.0. Road Side Drains:

86.1. Formation of Drain:

The road side drains shall be made in sizes and slopes as shown on drawings and/or instructed by the Engineer. The minimum side slope shall be as instructed by the Engineer. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts, outside plant area, as per instructions of the Engineer.

The excavated spoils shall be transported and filled in low areas within the plant area or in embankment as instructed by the Engineer. The lining for the drains shall be as per drawing and as mentioned in the schedule of items. Lining of drains may be of bricks or cement concrete blocks of MIS grade concrete as shown on drawing or as directed by the Engineer.

86.2. Surface/sub-surface drains:

This work shall consist of constructing surface drains in accordance with the requirement of these specifications and to the lines, grade dimensions and other particulars shown on the drawings or as directed by the Engineer-in-charge. Schedule of work shall be so arranged that the drains are completed in proper sequence with roadway and pavement works to ensure that no excavation of the completed works is necessary subsequently or any damage is caused to these works due to lack of drainage.

86.3. Surface Drains:

Surface drains shall be excavated to the specified lines, grades, levels and dimensions to the requirements. The excavated material shall be removed from the area adjoining the drains and if found suitable utilized in embankment construction. All unsuitable material shall be disposed of as directed.

The excavated bed and sides of the drains shall be dressed to bring these in close conformity with the specified dimensions, levels and slopes.

Where so indicated drains shall be lined or turned with suitable materials in accordance with details shown on the drawings.

All works on drain construction shall be planned and executed in proper sequence with other works as approved by the Engineer-in-charge with a view of ensuring adequate drainage for the area and minimizing erosion.

86.4. Sub-surface drains:

General:

Sub-surface drains shall be of close jointed pipes, surrounded by granular material/concrete laid in the trench of aggregate drains to drain the pavement courses.

Materials:

- A. PIPE: Pipe for the drains may be of metal/asbestos cement/ cement concrete/PVC.
- B. BACKFILL MATERIAL: Back fill material shall consist of sound, tough, and, durable particles of free draining sand-gravel material or crushed stone and shall be free of organic material, clay balls or other deleterious matter.

The backfill material shall be provided on the following lines.

- (i) Where the soil met with in the trench is of fine grained type (e.g. silt, clay, or a mixture of thereof) the backfill material shall conform to class-I grading set out in Table given below:
 - a) Where the soil met in the trench is of coarse silt to medium sand or sandy type, the backfill material shall correspond to Class-II grading of Table given below:
 - b) Where soil met in the trench is gravelly sand, the backfill material shall correspond to Class-III grading of Table. Thickness of backfill material around the pipe shall be as shown on the drawings subject to being at least 150 mm all-round in all cases.
 - c) Where black cotton soil or expansive soil is met, the backfilling shall be done with CNS material of approved thickness as per the construction drawing.

86.5. TABLE – GRADING REQUIREMENT OF BACKFIL MATERIAL:

Sieve	Percent by weight passing the sieve				
	Class-I		Class-II		Class-III
50 mm	---				
40 mm	---	---			100
25 mm	---	---			95 – 100
20 mm	---	100			
10 mm	100	90 – 100		---	50 – 100
4.75 mm	90 – 100	40 – 100			15 – 55
2.36 mm	80 – 100		25 – 40		0 – 25
1.18 mm	50 – 95	---	18 – 33		0 – 5
600 micron	30 – 75	5 – 15		---	
300 micron	10 – 30	0 – 7		---	
150 micron	0 – 10	---		---	
75 micron	0 - 3	0 - 3		0 - 3	

86.7. Culverts:

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the instructions of Engineer after clearing the site, etc., as per specifications of earthwork. Backfilling with ramming and watering shall be done after construction of the foundations.

The construction of culverts shall be done true to lines and levels and as shown on the drawing. The specification for masonry and/or plain and reinforced cement concrete shall be followed, as applicable.

86.8. Pipe Culverts and Drainage pipes:

86.9. Materials:

The drainage pipes unless otherwise shown on drawing as instructed by the Engineer shall be made of RCC and shall be either class NP2 or NP3.

Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP3 or of ROSO class for railway as decided by the engineer or shown in the drawing. All pipe shall meet the requirements of IS:458 – Latest edition and shall be procured from approved manufactures with collars as per manufacturing standard specifications. The bidder shall specifically mention the particular manufacturer's product he proposes to use.

86.10. Cement shall be ordinary Portland cement as per IS:269 latest edition.

Aggregate shall be as per IS:383 – Latest edition – maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller.

Fine aggregates for concrete shall be as per IS:383 – latest edition.

86.11. Laying of Pipes:

86.12. Laying of concrete pipes shall correspond to IS:783 – Latest edition – and to specification given below:

a) the foundation bed for pipe shall be excavated true to lines and grades shown on the drawings or as directed by the Engineer. When trenching is involved its width on either side of the pipe shall not be less than 150 mm nor more than one-third the diameter of pipe unless or otherwise instructed/ permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, boiling out water, etc., as required shall be done by the contractor, without any extra cost to the purchaser side slips, if there be any, shall be removed by the contractor without any extra cost to the purchaser. After laying of the pipes are completed, backfilling of the trenches shall be done in 250 mm layers, measured loose, clod sand lumps, broken, watered and compacted with iron rammers to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

86.13. When bed-rock or boulder strata are encountered excavation shall be taken down to at least 200 mm below the bottom level of the pipe with prior permission of the engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented material, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

Laying of pipes shall start from the outlet and proceed towards inlet.

All pipes and fittings shall be gradually lowered into the trench or placed on the supports approved means taking due care not to damage them. Under no circumstances the pipes shall be dropped into the trench or on supports from a height.

a) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS:783 – latest edition – having a projection ratio of not greater than 0.70, in which the pipe is carefully bedded on fine granular materials in an earth foundation exterior for at least ten per cent of its overall height, and in which earth filling material is thoroughly rammed and tamped in layers not exceeding 15

cm. in depth around the pipe for the remainder of the lower 30 per cent of its height.

If the pipe is laid in trench, pipe bedding shall be first class bedding as per IS:783.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M/s. The shape and dimension of the cradle shall be as indicated on the drawings or directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete has set.

b) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

c) The pipe culverts shall be made with proper care regarding the invert of the pipe, gradient, if any, etc., as specified on drawings and/or as instructed by the Engineer.

d) Where RCC pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and remaining height of block to be concreted subsequently.

e) The RCC pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part cement and 2 parts of clean sand with only enough water for work ability. Procedure of jointing shall be as per IS:783 – latest edition.

86.15. Relation with water supply pipeline:

Unless specifically cleared by the Engineer, under no circumstances shall drainage pipes be allowed to come close to water supply pipelines.

86.16. manholes and Inspection chambers:

The maximum distance between manholes shall be 30 meter unless specifically permitted otherwise. In addition at every change of alignment, gradient or diameter, there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed to as to be watertight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connection to existing pipelines shall be through a manhole.

Manholes shall be provided with standard covers, usually C.1. or as directed by the Engineer. The cover shall be close fitting so as to prevent gases from coming out.

87.0. Masonry:

87.1. Brick Masonry:

All bricks shall be of first class (Class-A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws or nodules of free time. Bricks shall be soaked in water for at least two hours prior, to use and shall be laid truly horizontal and vertical in headers and stretchers with cement mortar consisting of one part of cement and four parts of sand, unless otherwise mentioned in the schedule of items or directed by the Engineer, in layers not exceeding 1.5 M in height. Each layer shall be allowed at least 24 hours to settle itself before another layer is placed on it and every layer cured with water until the starting of next layer above it.

Materials for mortar such as sand and cement shall be of approved quality. Mortar shall be well mixed, first dry mixed and then by adding water slowly to have a thick workable consistency. Mortar shall be mixed in small batches consistent with the rate of consumption so that no mortar is used after one hour of mixing. Mortar joints shall be kept uniformly 10 mm thick and all joints should be full of mortar. Brickwork shall be carried up regularly in plumb every course being horizontal. No vertical joints shall come directly over one another.

Joints of the brickwork shall be raked minimum 10 mm deep using raking tool while mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. The brickwork shall be kept moist for 14 days.

All bricks which absorb water more than 20% of their own dry weight after being immersed in water for 24 hours shall be rejected. Brick should be as per IS:1077. Bricks shall have.

Construction joint at an interval of 30 m has to be provided.

87.2. Stone masonry:

All stones shall be from approved quarries, hard, tough durable, compact grained uniform in texture and colour and free from decay, flaws, veins cracks and sand holes. A stone shall not absorb more than 5 percent of its weight of water after 24 hours immersion. Samples shall be submitted by the contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

Stone shall be thoroughly soaked before laying, stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall not be less

than 8 mm and not greater than 25 mm. Atleast two stones shall run the full width of the wall for every square meter of surface area.

87.3. Pointing to Masonry:

After raking out of the joints, the brickwork shall be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water, mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finished with suitable tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean. The pointed surface shall be kept wet for at least three days for curing.

87.4. Plaster to masonry and concrete:

Before application of plaster the surface shall be cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent adsorption of water from the base course. Any excess water shall be mopped up.

Unless otherwise mentioned in the schedule of items plastering shall be done with cement sand mortar – 1 part by volume of cement to 4 parts by volume of clean, sharp, well graded sand. For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a water tight platform and minimum water added to achieve working consistency. For time required proportion shall be mixed on a water tight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall then be transferred to a mechanical mixer to which the required quality of cement is added and mixed for at least 3 minutes.

No mortar which has stood for more than half an hour shall be used.

Plaster, when more than 12 mm thick shall be applied in two coats. All plaster work shall correspond to IS:1661 latest.

87.5 Finish:

Generally, all plastered surfaces shall have a standard finish unless otherwise shown on the drawing or directed by the Engineer. The interior plaster shall be finished to a smooth surface by steel toweling. The exterior surfaces shall be finished with a wooden float.

However, if shown on the drawing or directed by the Engineer plastered surface shall have a neat cement finish. Immediately, after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per sq.m and rubbed smooth with a trowel.

88.0. Testing and acceptance criteria:

88.1. Roads:

All testing, as mentioned in the body of the specification and as mentioned in Clause No.900 of specification for roads and bridge works, 1983 published by IRC on behalf of Ministry of shipping and Transport (Roads Wing) shall be carried out by the contractor as per direction of the Engineer. No extra payment shall be made for such tests.

88.2. Masonry and Plastering:

Masonry and finish to masonry and concrete shall fully comply with the drawings, specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness and any other special criteria as mentioned in the body of the specification or as shown on drawing.

88.3. Cement : Concrete:

The strength requirements and acceptance criteria shall conform to the relevant clauses of IS:456.